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Evaluation of a Coast Guard Marine Portable Inspection Unit (MPIU)

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16. Abstract

This effort represents a second phase to a project that is exploring the concept of employing a portable computer inspection capability for Coast Guard marine inspectors. In the first phase of this effort, a set of general performance requirements was developed based on extensive interviews with field personnel, inspector workshops, and a non-developmental item survey. The second phase of this project, which is the subject of this report, addresses testing of the concept and ideas developed in the first phase through a technology demonstration at a Coast Guard field unit.

A working prototype of a Marine Portable Inspection Unit (MPIU) was developed for the demonstration. Inspection programs implementing the Coast Guard's tankship hull inspection and barge inspection books were developed. These programs closely follow the format of the CG-840 series books. Commercial supporting software was evaluated and acquired. The software developed included limited access to a reference database. Two MPIU systems were configured for the field demonstration.

A technology demonstration lasting 2-1/2 months was conducted at the Marine Safety Office in New Orleans, LA, during which inspectors conducted inspections of vessels using the two MPIU systems.

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METRIC CONVERSION FACTORS

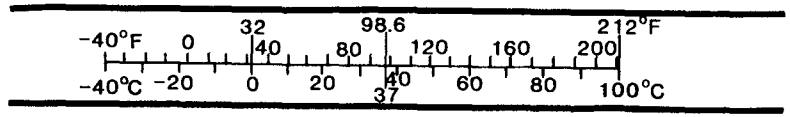
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	* 2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (WEIGHT)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (EXACT)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly).

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (WEIGHT)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (EXACT)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



EXECUTIVE SUMMARY

This effort represents a second phase to a project that is exploring the concept of employing a portable computer inspection capability for Coast Guard marine inspectors. In the first phase of this effort, a set of general performance requirements were developed based on extensive interviews with field personnel at Marine Safety Offices (MSOs) and Marine Inspection Offices (MIOs) across the country, inspector workshops, and a non-developmental item (NDI) survey. The NDI survey determined suitable hardware and software that was available at the time. The second phase of this project, which is the subject of this report, addresses testing of the concept and ideas developed in the first phase through a technology demonstration at a Coast Guard field unit.

A working prototype of a Marine Portable Inspection Unit (MPIU) was developed for the technology demonstration. Inspection programs implementing the Coast Guard's tankship hull inspection and barge inspection books were developed. These programs closely followed the format of the CG-840 series books. Commercial supporting software was evaluated and acquired. The software developed included limited access to a reference database. Two MPIU systems were configured. Each system was essentially comprised of a portable pen-based computer, a CD-ROM drive, a laptop PC, a digital camera, and developed MPIU software.

A technology demonstration lasting 2-1/2 months was conducted at the Coast Guard Marine Safety Office in New Orleans, during which inspectors conducted actual inspections of vessels with the two systems. The progress of the field trial was evaluated near the middle and at the end of the trial. This report documents the user's comments based on this short field trial.

A few general conclusions about the use of computer-assisted marine inspection include:

Inspectors are receptive to the concept and enthusiastic about the potential benefits of computer-assisted inspection data management.

The inspection software should be designed to take better advantages of the capabilities of portable computers rather than closely mimicking the inspection books.

Access to reference materials is one of the most useful capabilities of the inspection computer system, and this capability should be more fully exploited.

ACKNOWLEDGEMENTS

MAR, Inc. gratefully acknowledges the cooperation of the many Coast Guard marine inspection personnel, from senior officers to the most junior inspectors, who made valuable contributions to this project. Despite heavy workloads, a large number of inspectors in many locations made themselves available to answer questions during the development of the MPIU software. Those inspectors with whom MAR has dealt have made it clear that the U.S. Coast Guard marine inspector corps is a group of very dedicated, professional men and women who, despite the somewhat traditional nature of their duties, are not only willing, but eager, to incorporate modern technology into their profession.

In particular, the participation of the personnel from MSO New Orleans was essential to preparation of this report. MSO New Orleans tested the field computer concept for more than two months and provided many insights and comments on how well the system works and how it could be improved.

MAR would also like to to acknowledge John Hannon (G-MVI-1) for his help in coordinating meetings at CGHQ, keeping the appropriate personnel informed, and generally for his enthusiastic support for the project.

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1 BACKGROUND

1.1 The Coast Guard's Inspection Responsibilities

The Coast Guard is required by Title 46, U.S. Code (USC), to periodically inspect certain vessels registered in the United States or operating in U.S. waters to verify seaworthiness, structural integrity, and passenger and crew safety. Inspections also verify conformance with the pollution laws of Title 33, USC. Virtually all cargo-carrying and passenger vessels which use U.S. ports are subject to Coast Guard Inspection. A large number of previously uninspected U.S. registered commercial fishing vessels have recently become subject to inspection under the Commercial Fishing Industry Vessel Safety Act of 1988 and the regulations resulting from that legislation.

The Coast Guard maintains a corps of professional inspectors to carry out its inspection responsibilities. Most inspectors are uniformed Coast Guard officers, warrant officers, or senior petty officers, although many inspection departments have a few civilian inspectors and some have a significant number of civilians. Most of these inspectors are based at regional Coast Guard Marine Inspection Offices (MIOs) or at the inspection departments of regional Coast Guard Marine Safety Offices (MSOs) under the direction of the local Officers in Charge of Marine Inspection (OCMIs) and Chiefs of Inspection Departments (CIDs). A small group of highly experienced senior inspectors (the travelling inspection staff) operates out of CG Headquarters, functioning mainly in an advisory and troubleshooting capacity.

U.S. flag vessels are required to have a current Coast Guard Certificate of Inspection (COI) in order to operate legally in U.S. waters or elsewhere. This certificate is issued after an extensive initial inspection conducted during construction or upon entry of the vessel into U.S. registry. Periodic reinspections (generally every two years) are required to maintain the COI. For each reinspection, CG inspectors are required to conduct a close-up visual inspection of the exterior and all interior spaces of U.S. flag vessels.

Foreign-flag vessels operating in U.S. waters are required to have current Certificates of Inspection (COIs) issued by their countries of registry and must satisfy the requirements of the United Nations Safety of Life at Sea conventions of 1974 and 1983 (SOLAS 74/83), the 1966 Load Line Convention, the 1969 Tonnage Convention, and the 1973 Marine Pollution Convention as amended by the 1978 Protocol (MARPOL 73/78). USCG marine inspectors conduct periodic safety inspections of these vessels to ensure compliance and to ensure that they meet reasonable standards of seaworthiness and structural integrity. These inspections are generally not as extensive as those of U.S. flag vessels, particularly with respect to structural integrity.

1.2 The Marine Safety Database

The Marine Safety Information System (MSIS) is the Coast Guard's current computer-based marine safety database. Part of this system serves the needs of the merchant vessel inspection program, giving users across the country access to background information and current inspection status for each vessel inspected by the Coast Guard.

The vessel information in the MSIS is referred to, and some of it is updated, at every reinspection. The information includes permanent background information about the vessel's design, construction, and configuration which is entered during the initial certification process for the vessel. Whenever a vessel is inspected, issued deficiency reports, or when repairs are mandated or confirmed by reinspection, the MSIS record for the vessel is updated by the inspector or by administrative personnel in the inspection office.

Most inspection departments currently experience delays between the inspection and the final entry of a vessel's inspection records into MSIS. Due to these delays, a separate record of a vessel's current inspection and repair status, form CG-2832, the Vessel Inspection Record Card (generally referred to as the "Bridge Record Card"), is posted on each inspected vessel. All changes in a vessel's inspection status are recorded on this card. The card is the first thing checked when an inspector goes aboard a vessel, since it may contain more up-to-date information than is available through the MSIS.

Improvements to the MSIS are currently in progress. The improved version of the marine safety database is tentatively slated to be called the Marine Safety Network (MSN). Throughout the remainder of this report, the database will be referred to as the marine safety database. This reference applies to either MSIS or a future replacement.

1.3 The Inspection Process

Vessels are often inspected overseas, and one inspection trip may involve the inspection of more than one vessel. Most inspections of deep-draft vessels are conducted while the vessel is in a shipyard, but this is not always the case.

Smaller ships, boats, and barges are generally inspected by a single inspector; but, a team of inspectors may be assigned to deep-draft vessels. In the case of a team inspection, the vessel is usually divided up among the team members, with only one inspector visiting each space. If a particularly dangerous space must be inspected or if rafting or another hazardous access technique is used, inspectors may work together. In many cases, inspectors are accompanied by ship's crew members, owner's representatives, shipyard personnel, classification society surveyors or independent surveyors working for the shipowner.

Many inspections take more than one day to complete. During a multi-day inspection the inspector generally issues informal interim deficiency lists called "worklists" to the ship's crew. Worklist deficiencies are often corrected by the crew before the inspection is

completed, and if they are, they do not appear on the final inspection report. Inspections conducted during overhauls may extend over a considerable period of time, with repairs and reinspections of those repairs occurring during the overhaul period. Significant deficiencies that can't be corrected before the end of the inspection are scheduled for reinspection at a later date.

On infrequent occasions, an inspection begun in one location may be completed by another inspector or team in a different location. It is not unusual for repairs required as a result of an inspection to be completed in a location other than the inspection port, or in more than one location. In such a case, an inspector or inspectors other than the one who conducted the initial inspection may conduct a reinspection to verify that the repairs were completed properly.

Because of the rotation schedule for uniformed Coast Guard inspectors, it is rare that the same inspector conducts two consecutive inspections of the same vessel, or that the inspector who conducted the previous inspection is even stationed in the same geographical location when the next inspection is conducted.

1.4 The Phases of a Typical Inspection

An inspection of a vessel by USCG marine inspectors involves at least four distinct phases, preparation (at the office), the inspection itself (aboard the ship), documentation of the inspection (aboard the ship and at the office), and reinspection of corrected deficiencies.

Figure 1, which follows, shows the flow of a typical inspection with multiple inspectors.

1.4.1 Preparation

This first phase of the inspection takes place in the office. The inspector obtains a printout from the MSIS of background information about the vessel's configuration, equipment, machinery, structure, and manning requirements. In addition, the MSIS listing of the vessel's current inspection status is printed out. The combined printout is the Marine Inspection Pre-Inspection Package (MIPIP or "PIP"). If available, records of previous inspections are obtained from files in the office. Vessels are frequently inspected in a port other than the vessel's port of registry, in which case the inspectors may obtain copies of the printed records of past inspections from the CG inspection office in the home port. Other information may be obtained from inspectors who conducted previous inspections, if they can be contacted.

The inspector also assembles a package of regulatory and reference materials (in text form) which might be pertinent to the inspection. These materials are generally carried to the ship by the inspector. Due to space and weight limitations, inspectors are often unable to carry with them all reference materials which might be needed during an inspection.

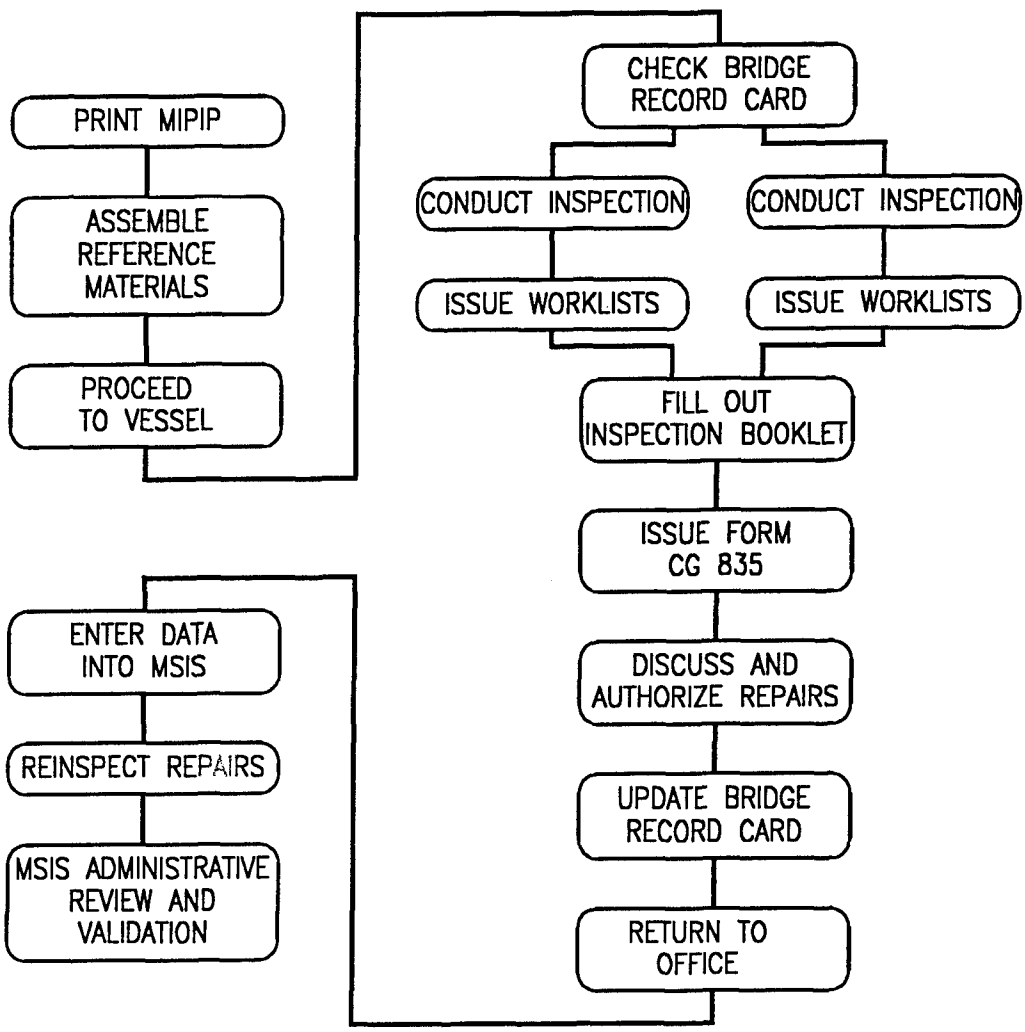

Figure 1 Flow Chart of A Typical Inspection

1.4.2 Conducting the Inspection

The inspector (or possibly more than one inspector in the case of larger vessels) proceeds to the vessel. Immediately upon arriving on board, the Bridge Record Card (if available) is checked to verify the vessel's current inspection status contained in the MIPIP

printout. Pertinent information from the Bridge Record Card may be copied down for inclusion in the inspection records.

Once aboard the vessel, the inspector (or inspectors) generally set up a temporary office in a stateroom or other space where their reference materials and other paperwork are kept, and where they meet with ship's crew and representatives of the vessel owners and the shipyard. The inspector(s) then make the rounds of the ship, recording inspection findings in handwritten or sketch form on a pad. Copies of the inspection booklet may be carried for reference, but the official booklet is generally not filled in until the inspection has been completed.

1.4.3 Documenting the Inspection

After completion of the inspection, the inspector (or the inspection team for a large vessel) assembles the notes from the inspection, and completes the inspection booklet (CG-840) appropriate to the vessel and to the type of inspection being conducted. The results of the inspection are discussed with the ship's master, chief engineer, or other crew members. The vessel's officers, in consultation with owner's representatives and shipyard personnel, may propose repairs to correct deficiencies found during the inspection. Repair proposals may be approved by the inspector immediately or may be referred to the CID or OCMI.

The inspector (or the head of the inspection team) writes the official textual narrative (the *inspection diary*) of the inspection findings. The diary is often handwritten on board, then transcribed to a computer file at the office. Some inspectors who own notebook computers carry them on inspection trips to facilitate preparation of the diary. Before the inspector(s) leave the vessel, a deficiency report (form CG 835) may be issued to the master of the vessel, and the bridge record card is updated.

Back at the office, the inspection book, the inspection diary and a copy of any CG-835 form are placed in the vessel's hardcopy file. Either the inspector or an administrative assistant extracts the appropriate information from the inspection documentation, applies the proper codes, and enters the record of the inspection into the Marine Safety Information System (MSIS) database. At the discretion of the inspector, a narrative synopsis of portions of the inspection diary may be entered into the MSIS as an attached file. After review, editing, and correction by senior administrative officers at the MIO/MSO, the MSIS entries made by the inspector are validated and then become available to all users of the system.

1.4.4 Reinspection of Deficiencies

Repairs of other actions to correct deficiencies may be required immediately or within a specified time period after completion of the inspection. These corrective actions are often verified by inspectors. The inspector reinspecting the repairs may not be the same inspector who conducted the initial inspection, and the reinspection may be done by a different office.

1.5 The Inspector's Equipment

Inspectors generally carry a minimum amount of equipment during the actual inspection since crawling into tight spaces and climbing is almost always necessary, and any equipment interferes with their mobility. The inspector's tool kit is typically limited to a flashlight, a hammer for scaling rust, a wire brush for removing debris from surfaces, and possibly an inspection mirror.

Protective equipment includes a hard hat, safety glasses, coveralls, gloves, and steel-toed shoes. Safety equipment may include a life vest (when needed), a safety harness, an emergency breathing apparatus, a portable oxygen analyzer, and an explosive gas indicator. Many inspectors chose to do without some or all of this safety equipment because it restricts their mobility.

The inspector's data collection equipment is typically limited to a pencil and a small paper pad. A small percentage of inspectors occasionally use portable voice-activated tape recorders in addition to the pad and pencil.

A significant number of inspectors choose not to bring any equipment into a dangerous location like a tankship's cargo spaces which cannot fit into their coveralls pockets or be clipped to their coveralls or belt. Some inspectors carry a small tool bag with a shoulder strap. Such a bag requires some handling and attention and interferes with hands-free climbing.

1.6 Potential Areas for Improvement

Prior to the effort reported here, MAR, Inc., conducted a study for the Coast Guard Research and Development Center entitled "On-Site Marine Inspection Data Capture," reference 6.1. This project laid the groundwork for the current effort. A final report on this study was delivered to the Coast Guard Research and Development Center in December 1992. The On-Site Marine Inspection Data Capture effort is referred to as Phase I in this report.

The workshops and discussions preceeding Phase I indicated potential areas for improvement of the inspection information management process. These needs were identified in a high level workshop conducted in June of 1989 and reported in reference 6.2. This workshop addressed both the short and long term needs of the Coast Guard's Marine Safety, Security, and Environmental Protection (M) Program. The findings from the field survey and inspector workshops conducted as part of Phase I confirmed those needs and revealed several other potential areas for streamlining the management of inspection information.

The Statement of Work for Phase I suggested three broad categories for potential improvement which are detailed in the following subsections. Discussions held with inspectors as part of Phase I substantiated these suggestions.

1.6.1 Data Collection and Management

The process by which inspection information flows from the initial collection point aboard ship to its eventual entry into the marine safety database needs to be streamlined to eliminate some or all of the intermediate steps of transcription and re-entry of data inherent in the current process. A data collection system which eliminates unnecessary data manipulation by the inspectors would help to minimize the delays which often prevent inspection information from becoming available in the marine safety database in a timely manner.

Aside from the summary of inspection data entered into the marine safety database, the official records of an inspection are presently in paper form and are fully accessible only in the vessel's port of registry. Replacement of the present inspection records (the CG-840 series inspection booklets and the inspection diary) by computerized equivalents would not only eliminate the transcription and re-entry of data during the inspector's documentation of the inspection, but would make these records readily available to inspectors in any location, provided the marine safety database had provisions for this.

During Phase I interviews with inspectors, they emphasized the need to preserve more of the details and more of the subjective "flavor" of inspections than the present methods of recording and preserving inspection data allowed. They also saw a need to improve the efficiency and timeliness of the processing and entry of inspection data into the marine safety database.

1.6.2 Access to the Experience of Senior Inspectors

The average experience level of current inspectors is quite low. If the less experienced inspectors had access to a distillation of the inspection techniques and decision-making processes developed through experience by senior inspectors, their efficiency and effectiveness could be improved. A computer-based inspection guidance and decision-making aid might provide this access. Such a capability would fall in the general category of Artificial-Intelligence (AI), and more specifically, in the category of expert-systems or knowledge-based systems.

1.6.3 Improved Access to Reference Materials

The body of statutory, regulatory, and reference materials with which inspectors must be familiar continues to grow and many of its components are frequently updated. The physical volume and weight of the text and graphical materials involved, the growing complexity of the reference materials, and the low average experience level of inspectors indicate a need for digital storage and a computerized reference database with a searching capability. Context sensitive help could also be used to bring up pertinent information on an issue at hand.

1.7 Phase I Recommendations

The following recommendations were made to the Coast Guard at the conclusion of the Phase I study. These recommendations form the basis for the Coast Guard's statement of work for the effort reported here.

1.7.1 On-site Computer

The Phase I report recommended that inspectors be provided with a pen-based computer for use while conducting inspections. This computer would implement an computerized adaptation of the particular CG-840 series inspection booklet appropriate to the inspection being conducted. The computer would prompt the inspector for responses to standard entries, and would allow entry of sketches and textual comments. The program would store the entered data in a database for use with the on-site computer, the on-board computer, and a home-office computer which prepares a record of the inspection for storage on the marine safety database.

The on-site computer would also provide for searching and display of reference and regulatory materials which are frequently used by inspectors.

1.7.2 On-Board Computer

A keyboard-based notebook-type portable computer, carried on board the vessel to be inspected, but not carried by inspectors while actually conducting an inspection, was recommended as an on-board base station. Data collected by the on-site computer (or more than one on-site computers in the case of inspections conducted by more than one inspector) would be merged by a program in the on-board computer. The on-board computer, in addition, would provide access to a more extensive database of reference and regulatory materials than could be accommodated by the on-site computers, and would be used for word-processing tasks such as filling out and printing forms and creating the inspection diary. The software would allow sketches prepared on the on-site computer and digitally stored photographs to be included in the diary.

The on-board computer would have an internal hard drive and floppy drive, and would connect to an external removable hard drive and to a CD-ROM unit.

The collected inspection data would be stored on the removable hard-disk drive of the on-board computer. The removable drive allows the records of the inspection to be transferred from the on-board computer to a desktop workstation connected to the marine safety database. The home-office workstation would provide any necessary format conversion between the inspection system and the marine safety database. At the time of the Phase I report, laptop and pen computers had small hard drives and many had no floppy drives. Also, the size of inspection files was expected to exceed the capacity of a single 1.44 MB floppy disk.

1.7.3 Inspection Records

It was recommended that the digitally stored inspection record file in the marine safety database (which may also be stored for back-up purposes at the inspection office) be designated as the official record of the inspection. Paper copies of inspection records would no longer be kept.

Computerized storage of information would allow a greater amount of information about each vessel (including plans) and more detailed records of past inspections to be kept and made available to inspectors. Most of the vessel information and past inspection records would be available to users of the marine safety database at locations other than the vessel's port of registry.

1.7.4 Pilot Project

It was recommended that a pilot project (technology demonstration) be conducted to test the concept of computerized inspection data management and to evaluate the strategies proposed in the Phase I report. The pilot project should be limited in scope with respect to the types of inspections covered and in the extent of the custom-developed applications. This would allow the project to be implemented quickly and with moderate expense. However, within the limited scope, it was recommended that the project include a wide range of hardware and software and expose these to as many inspectors as possible.

These recommendations in reference 6.1 were reviewed by the Coast Guard and a statement of work was prepared for the effort reported here.

2 INTRODUCTION

This report describes a project entitled "Development of a Coast Guard Marine Portable Inspection Unit (MPIU)" which was conducted for the Marine Engineering Branch of the U.S. Coast Guard Research and Development Center by MAR, Inc. This project was a field evaluation of the marine inspection data management strategies recommended by MAR in a previous project (Phase I) entitled "On-Site Marine Inspection Data Capture". Both the work reported here and the previous Phase I work are part of an ongoing effort by the Coast Guard to improve the collection of merchant vessel inspection data and to improve data management support for field inspectors.

2.1 Statement of Work Requirements

The Statement of Work (SOW) provided performance requirements based on the results of Phase I and left the choice of hardware and software used to the contractor's discretion. The hardware and software selection were provided to the Coast Guard for approval as discussed in Section 3 of this report.

The SOW was subdivided into three subtasks which are summarized below. The SOW refers to a "pilot project." However, because of the limited scope of the evaluation the name was later changed to a "technology demonstration." A pilot project is generally of greater extent.

Task 1 - Prototype System Configuration This task required the contractor to assemble and develop two prototype MPIU systems which best fulfill the performance requirements. The MPIU systems were required to perform the following functions:

- implement the computerized version of the inspection booklets on the pen computer;
- transfer programs between the laptop and pen computers;
- provide access to a large database in a CD-ROM unit attached to the laptop;
- transfer collected data from the pen computer to the laptop computer;
- merge data collected by more than one pen computer into a single database;
- combine data collected by pen computers with diaries and other documents; prepared on the laptop into a final inspection datafile; and
- fill in and print out records of the inspection.

The transfer of data to and from the marine safety database was not addressed as part of the pilot project. The project focused on implementing two inspection booklets, the Tankship Hull Inspection Book and Barge Inspection Book. These spanned the range between very complex tanker inspections and the relatively simple barge inspections. The contractor was also required to provide computerized access to a limited amount of reference material, primarily information from the Code of Federal Regulations.

Task 2 - Field Unit Testing This task was conducted by a Coast Guard Field unit (New Orleans Marine Safety Office). The contractor was to provide the hardware, software, user's manuals and training to permit the trial to take place. The contractor was also to provide hardware and software support during the field trials. The extent to the trial period was two months. This was later extended to about 2-1/2 months.

Task 3 - Evaluation of Field Unit Impact This task required the contractor to evaluate the effectiveness of the MPIU in its overall ability to streamline the Coast Guard ship inspection business and document marine inspector feedback. The contractor was also required to evaluate the impact on safety and mobility of inspectors when using this technology. Task 3 is the principal subject of this report.

2.2 Goals of the Study

The principal goals of the MPIU technology demonstration, as stated in the SOW, were to:

1. Allow inspectors to evaluate the concept of computerized inspection data management and to document their feedback on how effective it is in streamlining the business of ship inspection documentation;

2. Evaluate the hardware and overall concept of computerized inspection data collection under a range of environmental conditions including adverse lighting conditions, temperature extremes, exposure to oil and other factors; and

3. Identify the extent to which carrying a portable computer affects an inspector's safety and mobility.

In addition to the principal purposes described above in the statement of work, the pilot study afforded the opportunity to:

1. Evaluate the suitability of the particular commercial software packages chosen for the pilot study and

2. Evaluate, by actual experience, the level of effort required to develop custom inspection applications.

The recommendations of Phase I are incorporated into this project except that a comparison of the software used was done subjectively by the contractor. Two inspection booklets were implemented rather than the one recommended in Phase I. This provided a wider range of field test possibilities. The main limitation on the technology demonstration was the lack of an interface with the marine safety database which prevented the inspectors from testing the principal time saving feature of the MPIU system predicted in Phase I. However, it was impractical to produce this interface in the time frame of the project.

3 DESCRIPTION AND SCOPE OF TECHNOLOGY DEMONSTRATION

This project was a technology demonstration to evaluate some of the concepts of computer-assisted marine inspection in the field. All of the hardware used in the study was available off-the-shelf. The operating systems, system software, and some of the supporting application software were selected from commercially available products. The programs which implement the Coast Guard's tankship hull inspection book and barge inspection book were written specifically by MAR, Inc., for this project.

The MPIU project included four principal phases:

Identification and acquisition of hardware and support software - Potentially useful commercially available software and hardware was evaluated. Those items which were found to be most suitable for the project were selected for inclusion in the system. Software was purchased, and hardware was either leased or purchased.

Development and testing of the inspection programs - The contractor wrote and tested the software to implement the computerized implementations of the Tankship Hull Inspection book (CG-840S) and the Barge Inspection book (CG-840E).

Field Trials - Two independent MPIU systems were configured and tested. The two systems included slightly different hardware but used the same software. The systems were delivered to the U.S. Coast Guard Marine Safety Office in New Orleans. The contractor trained inspectors in the use of the hardware and software at the beginning of the field trial and returned to evaluate the progress of the project mid-way through the trial.

Evaluation - Upon completion of the field trial, the inspectors who had used the systems were interviewed. Their evaluations of the system and their suggestions for future development were used by the contractor to evaluate the potential benefits and problems of computer-assisted marine inspection.

3.1 Identification and Acquisition of Hardware and Support Software

3.1.1 Hardware

The principal technical feature of the MPIU hardware was the use of pen-based computers. These computers are IBM-compatible, but can operate without keyboards, using a pen-like stylus which serves as both a pointing device and a text-entry device. A specially-adapted version of Microsoft Windows allows recognition of characters printed on the screen with the pen, and the pen can also be used as a freehand sketching device within Windows programs which have been specifically written to allow this type of input.

Two inspection computer systems were configured. One system was based on a small pen-based computer (the Dauphin DTR-1) and a standard laptop computer (an IBM ThinkPad 300); the other system was based on a larger pen-based computer which could also serve as a laptop (the Compaq Concerto). Both systems included a digital camera (two different versions of the Logitech FotoMan), a portable printer (HP DeskJet 310 ink-jet), and a portable CD-ROM reader (Microsolutions Backpack). The computer hardware used in the MPIU systems conformed to the IBM-compatible standard.

The SOW tasked the contractor with choosing hardware meeting the performance requirements specified. Pen-computer hardware has advanced significantly in the last few years. Much better hardware was available at the start of this effort than was on the market at the end of the Phase I study. MAR reviewed advertising literature at the beginning of the project and recommended hardware to the Coast Guard that they found acceptable. Our criteria for selecting all hardware was that it meet the minimum performance requirements and be readily available for immediate purchase or lease at a reasonable price. Most of the effort was devoted to choosing the pen computers as these were key to the evaluation. A pen computer was desired that represented a small size unit with a small screen size and another computer was desired that had a "full size" screen but necessarily weighed more. An excellent computer for each category was located. In fact, the full sized pen computer chosen also was a good laptop computer. As a result, it was used both as the pen computer and laptop. The small sized pen computer needed to have a separate laptop computer since its keyboard was too small to be usable.

The remaining hardware was less critical. MAR chose good representatives from among many competing and suitable candidates. The laptop computer chosen could have been replaced by any number of laptops on the market. The printer chosen also has many suitable rivals. The CD-ROM unit had a limited number of competitors. At the time this effort began, the Logitech digital cameras were one of the few available at a reasonable price.

The following paragraphs provide a more detailed description of the hardware used in Dauphin DTR-1 based system and the Compaq Concerto based system.

The Dauphin DTR-1 MPIU System

The hardware provided with the Dauphin-based MPIU system is listed below.

The Dauphin DTR-1 pen-based computer is a pocket-sized computer with a 6" diagonal backlit monochrome display, weighing 2.5 lb with batteries and measuring 9" x 5.5" x 1.25" It has a 25 MHz 486SLC processor and operates under MSDOS and Windows for Pen Computing (a specialized version of Windows 3.1). This model has 6 MB of system memory and a 40 MB hard drive. It can operate from batteries or from an AC power supply. Battery life is up to 3 hrs and the battery can be changed "on the fly" without data loss.

The IBM ThinkPad 300 laptop is a computer with a 25 MHz 386 processor, an 8 MB system memory, a 120 MB hard drive, and a 10" diagonal backlit monochrome LCD VGA display. It weighs 6.7 lbs and measures 12" x 9" x 2." It can operate from an internal battery or from AC power.

The HP DeskJet 310 Portable Printer is an ink-jet printer with a 360x360 dots/inch resolution. The same printer was used with the Compaq Concerto based system. The printers used in this project were equipped for black-and-white printing only, and were powered by an AC power supply. Optional batteries and color printing cartridges are available for this printer.

Microsolutions Backpack CD-ROM unit is a semi-portable desktop unit which is powered by an AC adapter and communicates with the computer by means of a parallel port connection. The same CD-ROM unit was used with each system.

Logitech FotoMan Digital Camera is a monochrome digital camera with an integral flash unit and automatic exposure control. The camera itself is a self-contained unit with a rechargeable battery. It can store up to 32 images. Each image has 256 shades of gray. The base unit provides connections to the DC power supply and to the serial port of a computer and fits into an optional desk stand. Once the camera is connected to the base unit and the cable is connected to the computer, the FotoMan program provided with the camera manages the loading of the images from the camera into the computer.

Figures 2 shows the Dauphin DTR-1 MPIU system. From left to right in Figure 2 are the Dauphin DTR-1 and its pen, the IBM ThinkPad 300 laptop and mouse, and the Logitech FotoMan Plus digital camera. The cables, power supplies, and the Dauphin's removable keyboard are not shown. This photograph, along with Figures 3 and 4, was taken with the Logitech FotoMan digital camera and was processed with Logitech FotoTouch software.

Figure 2 The Dauphin DTR-1 MPIU System

The Compaq Concerto MPIU System

Figure 3 shows the Compaq Concerto MPIU system. From left to right are the HP DeskJet printer, the Compaq Concerto and its pen, the Microsolutions CD-ROM drive, and the Logitech FotoMan Plus digital camera. Cables, power supplies, and the Compaq Concerto's removable keyboard are not shown.

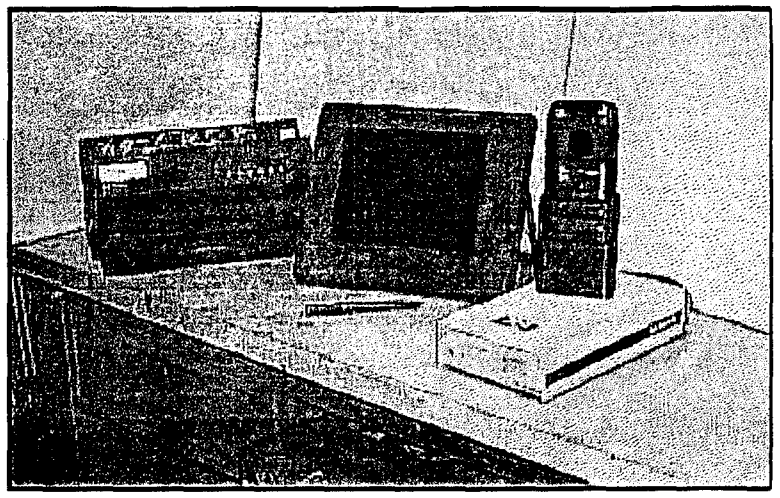

Figure 3 The Compaq Concerto MPIU System

The hardware provided with the Compaq-based MPIU system includes:

Compaq Concerto pen-based computer is a tablet sized pen computer with a 10" diagonal backlit monochrome display, weighing 5.5 lb. with battery (6.7 lb. with keyboard), and measuring 13" x 10" x 2". It uses a 25MHz 486DX processor, has 8 MB of system memory and a 118 MB hard drive. It can serve equally well as a mobile hand-held pen-computer and as a desk-based laptop computer. It can operate from batteries or from an AC power supply. Battery life is 2-4 hrs and the battery can be swapped without data loss.

HP DeskJet 310 Portable Printer

Microsolutions Backpack CD-ROM unit

Logitech FotoMan

Digital Camera

Figure 4 shows the Dauphin DTR-1 computer to the left of the Compaq Concerto computer. This photo shows the relative size of the two computers.

3.1.2 Software

MAR was required by the SOW to recommend for Coast Guard approval software meeting the performance requirements specified. This included the programs written by MAR to implement computerized versions of the two inspection books as well as off-the-shelf software to enhance the inspection book software. Software was needed to search the reference database, to connect with the digital camera, to transfer files between computers, and to allow viewing of engineering drawings. Viewing engineering drawings was not an

essential feature but was included to demonstrate the potential for computerized drawing viewing and markup.

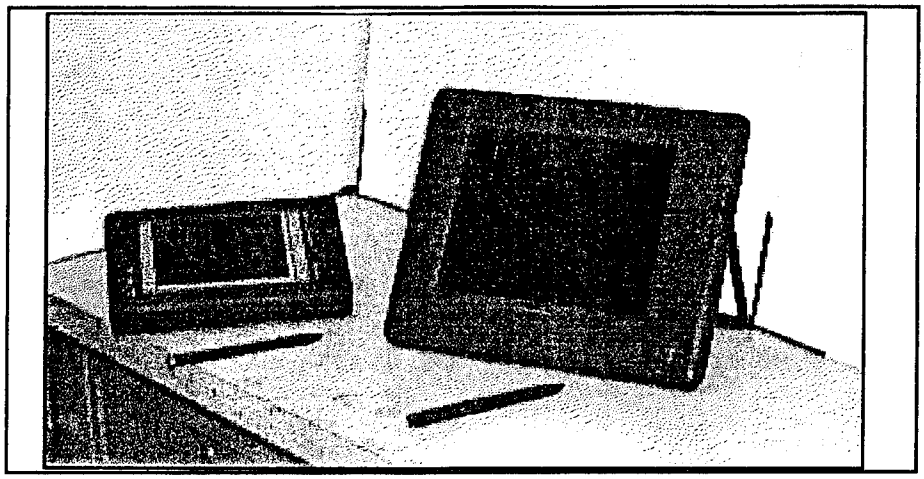

Figure 4 The Dauphin DTR-1 and Compaq Concerto Computer

The first step was choosing an operating system to run the software. The Phase I report recommended that both Windows for Pen Computing and PenPoint software be evaluated. By the beginning of this effort it was clear that Windows for Pen Computing was better accepted and provided better compatibility with existing programs. It was therefore the clear choice.

The following sections discuss the software chosen. In most cases there are competing products of equal capability. The criteria for software products was similar to that for hardware. The products had to meet the minimum requirements of the SOW and be readily available at a reasonable price. MAR attempted to choose good products in each category but the software chosen is not necessarily the best available for the job.

Microsoft Windows for Pen Computing

The full version of PenWindows was run under MS-DOS 6.2 on the two pen-based computers. Parts of the Pen Extensions, not including handwriting recognition, were installed on the IBM laptop computer to allow the tankship and barge inspection programs to run on that machine.

Windows for Pen Computing, or "PenWindows", is an enhancement of the Windows 3.1 operating environment which provides support for pen-based computing. The enhancement is in the form of a group of files known as the "Pen Extensions" to Windows 3.1. The Pen Extensions include the management of handwriting recognition. Most of the forms used in the computerized versions of the inspection books make use of features of the "Pen Extensions."

ZYFind

The Phase I report recommended that the marine inspection computer system provide on-line access to the reference and regulatory materials needed by inspectors. Because of the material that inspectors use is contained in a large number of individual books and manuals,

they currently carry only those books which they use most frequently, leaving the rest at the office for later reference. The report in reference 6.1 described three categories of reference material, based on frequency of use.

The MPIU system was required to include on-line access to Title 46 of the Code of Federal Regulations (CFR), which made up "Category 1," the most frequently used reference material. MAR extended this material to include parts of Title 33, which is an important portion of the "Category 2" material.

ZYFind is a text-searching program produced by ZYQuest, Inc. It was loaded onto the IBM ThinkPad laptop and onto the Compaq Concerto pen-computer to provide on-line access to the reference database (Titles 33 and 46 of the Code of Federal Regulations). The appropriate sections of Titles 33 and 46 were subdivided into individual files, one for each Part. These files were pre-processed with ZYIndex, a companion product to ZYFind, which constructs indexes. In this case one index was created for each Subchapter, which generally comprises a number of individual parts, and thus a number of files. ZYFind searches for text with the help of these indexes.

ZYFind allows multiple files to be searched simultaneously for keywords or combinations of keywords entered by the user. Boolean combinations of keywords can be used to limit or expand the range of searches. A special file of the Subchapter Tables of Contents and Outlines was prepared. By using this file, users could conduct a hierarchical search of selected indexes, a feature not inherent in ZYFind. This technique not only led users to the text corresponding to a selected section heading, but it also provides a list of all references to the selected section which occur in the indexed files. This feature is not provided by standard hierarchical search routines.

FotoMan and FotoTouch

Logitech FotoMan and FotoTouch software was provided with the digital cameras from the same manufacturer. Logitech FotoMan is the program which controls access to the FotoMan digital cameras. This Windows-based program was installed on all of the computers. It accomplishes the transfer of digital photographs from the cameras to the computers.

FotoTouch is Logitech's image editing program. It was included on the systems primarily as an optional demonstration program. FotoTouch's function is computerized enhancement of digital images such as photographs.

Windows Write

Write is a simple word-processing program which supports all of the standard features of Windows, and which is included as an integral part of Windows. It was the standard

word-processing software for the MPIU system. Users were free to install their own word-processing software on the systems, subject to disk space limitations.

Interlink

Interlink is a utility program included with MS-DOS 6.0 and later releases. Interlink allows two computers to be connected together by special parallel or serial cables, giving the "client" computer access to the hard and floppy disk drives of the "server" computer. Interlink provided a convenient and easy to use way of transferring files between laptops or desktop computers and pen-based computers. The Dauphin DTR-1 did not have a floppy drive, so the use of Interlink was necessary. The Compaq Concerto did have a floppy drive, but transfers via Interlink are often faster and easier than via floppy disk swapping, especially if large files or a large number of files are transferred.

FieldNotes

FieldNotes is a commercial Windows-based program developed specifically for pen-based computers. It is primarily a graphical, spatially-oriented database program, which has many functions. The reason for including it in the MPIU system was for its capability to provide markup and annotation capability for underlying drawings, which can be imported in either bitmap or vector formats. FieldNotes was not an essential part of the MPIU system, and no drawings were available in digital format for vessels inspected during the technology demonstration.

RuleFinder

RuleFinder is a CD-ROM-based database published by Lloyd's Register of Shipping. The database includes Lloyd's rules for building and classing steel, wood, aluminum, and composite vessels, as well as a number of international maritime safety regulations. The access program was installed only on the Compaq Concerto pen/laptop computer. The access program would not run on the IBM laptop due to an apparent hardware incompatibility, and there was not sufficient disk space on the Dauphin DTR-1 pen computer for the access program. RuleFinder, like FieldNotes, was not an integral part of the MPIU system. It was installed at the request of the Coast Guard primarily for demonstration purposes.

3.2 Development and Testing of the Inspection Programs

3.2.1 MPIU Program Features

The contractor developed two computer programs designed to replace the functions of the Coast Guard's Tankship Hull Inspection Book (CG-840S of 7-78) and Barge Inspection Book (CG-840E of 2-79) on pen-based computers. These new computerized inspection books run under Microsoft Windows for Pen Computing. The tankship and barge programs are separate programs, but they are based on a common library of source code developed

specifically for the MPIU project. The software was written using the Professional Edition of Microsoft Visual Basic for Windows, Version 3.0. Additional programming capabilities were added with a third-party Visual Basic enhancement package, Sheridan Software's VBAssist, which speeded the development process.

Many of the differences in appearance and function between the tankship and barge programs are created by configuration data files which are loaded by the programs when they are executed. The configuration files begin as plain American Standard Code for Information Interchange (ASCII) text files. When the program is first executed, the configuration information in these files is compiled and stored by the program in a more efficient format. During subsequent runs, the program uses these compiled configuration files, which speeds loading and execution. A few of the differences between the tankship and barge programs which cannot be controlled by configuration files are hard-coded.

The programs closely follow the organization of the inspection books, using topics such as firefighting, cargo handling, personnel, pollution prevention, etc, as major categories. The primary divergence from the format of the paper inspection books occurs in the tankship program. In the paper tankship book, some topics are repeated in the "U.S.", "Foreign", and "U.S. and Foreign" sections. These multiple occurrences of inspection topics have been consolidated in the inspection programs, so that the proper entries are automatically displayed for the flag of the ship being inspected. In many cases, especially for vessel information sections, the appearance of the computer screens is similar to that of the pages of the inspection book.

The inspection book programs are designed primarily for pen-based computers, but they can also run on laptop or desktop computers (with the loss of the pen-sketching functions). Some of the important features and capabilities of the software are:

Loading vessel background information from previous inspections. Many entries are not expected to change from one inspection of a particular vessel to another - this feature eliminates the need for re-entry of information which is unlikely to change over one or two years.

Recording inspector responses to individual check-off items. "SAT/UNSAT/NA" are provided for each inspection check-off item. These items correspond directly to bulleted items in the inspection books. They are checked by a simple tap of the pen. These entries are "grayed-out" (inactivated) when they do not apply because of the vessel's flag.

Recording text comments. Multiple text comments can be created and linked to each individual check-off item. Text entry is done by printing on the screen with the pen, resulting in "ink" which is recognized by the system and stored as standard ASCII text. Text can also be entered into comments with a keyboard. Each comment is assigned one of three states: "Open", "Cleared", and "General", and these states can be changed

by the inspector at any time. "Open" comments are treated in the same way as "UNSAT" checkmarks. Comment status allows implementation of a narrative-based inspection, as now practiced by several inspection offices, without sacrificing the automatic identification and processing of deficiency information by the report-generation module of the program. In addition, "Cleared" comments allow information about deficiencies found at the beginning of an inspection, but corrected during the course of an inspection, to be retained as a record, in accordance with the latest G-MVI inspection documentation policies. Comments can be edited at any time.

Recording of sketches. As with comments, any number of freehand sketches made with the pen can be linked to any individual check-off item. These sketches can be edited at any time. The sketching function is only available on pen-based computers since this capability is not provided under Windows 3.1 software, only under Windows for Pen Computing.

Use and Annotation of Digital Photographs. Digital photographs can be linked to any check-off item and can be annotated by the inspector by sketching with the pen over or alongside the photographic image.

Annotation of Other Images. Like photographs, pre-existing bitmap images of drawings such as vessel arrangement plans or structural details can be linked to check-off items and, like photographs, they can be annotated by pen sketching.

Report generation. Both hard-copy and disk file reports can be generated, and they can include: all outstanding deficiencies; all outstanding and cleared deficiencies; or all check-off fields. Deficiency reports can be used by inspectors as worklists which are issued informally to a ships's personnel during an inspection. Report fields are labeled with the name of the item, the subtopic and main topic which contain the item, and the status of the item. Comments, sketches, and photographs linked to check-off items can be printed with any type of report at option of the inspector. The existence of comments and "inks" is noted for each item in a report even if the comments and inks are not printed.

Merging Inspection Files. When a large inspection is conducted by more than one inspector using more than one pen-computer, the resulting independent inspection files can be merged. Many entries are automatically combined according to certain logical rules. The inspector is prompted to edit or choose between duplicate or ambiguous entries.

The inspection programs store inspection data in several files. The principal data is stored in an ASCII database format. The data file for each inspection is a single record and each item of information is a single field in that record. Several types of data are retained in the inspection database file: the states of the SAT/UNSAT/NA checkboxes, any text or numbers entered as data or comments, digital "ink" entered as sketches or annotations to

template drawings and photographs. In addition to the inspection database, digital photographs and template drawings are stored as independent bitmap files, the rough inspection diary is stored as an independent ASCII text file, and another file stores the states of status indicators in the program which show, on each screen, the existence of deficiencies and incomplete entries on any subordinate screens.

3.2.2 MPIU Program Organization

Figure 6 (next page) shows the hierarchical structure of the MPIU programs. Inspection topics are selected using a button bar on the main form which is always in view. Figure 5 shows this button bar. Figure 7 shows a typical first-level form. This form contains buttons for selecting second-level forms and a brief description of the content of the second-level forms beneath it.

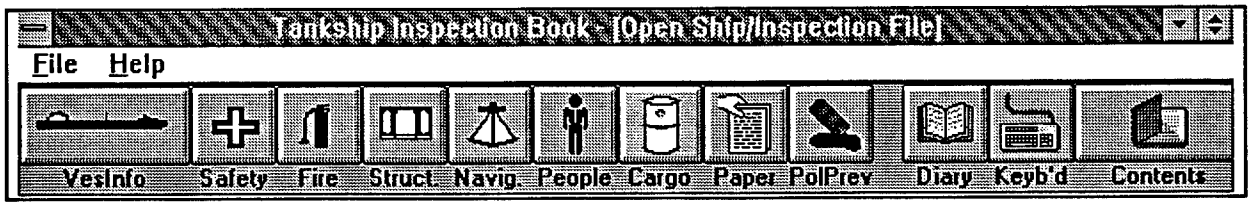

Figure 5 Upper Part of Main Form for Tankship Program

A typical second level form is shown in Figure 8 with its topics and selection buttons for the related third level forms. A typical third level form is shown in Figure 9. Comments and inks can be attached to each line item on this form. The small "C" and "I" to the left of the buttons indicates that there are comments and inks currently attached to a line item.

More detailed information on program function is contained in the User's Manual attached as Appendix A. The User's Manual shows many more forms than have been included here.

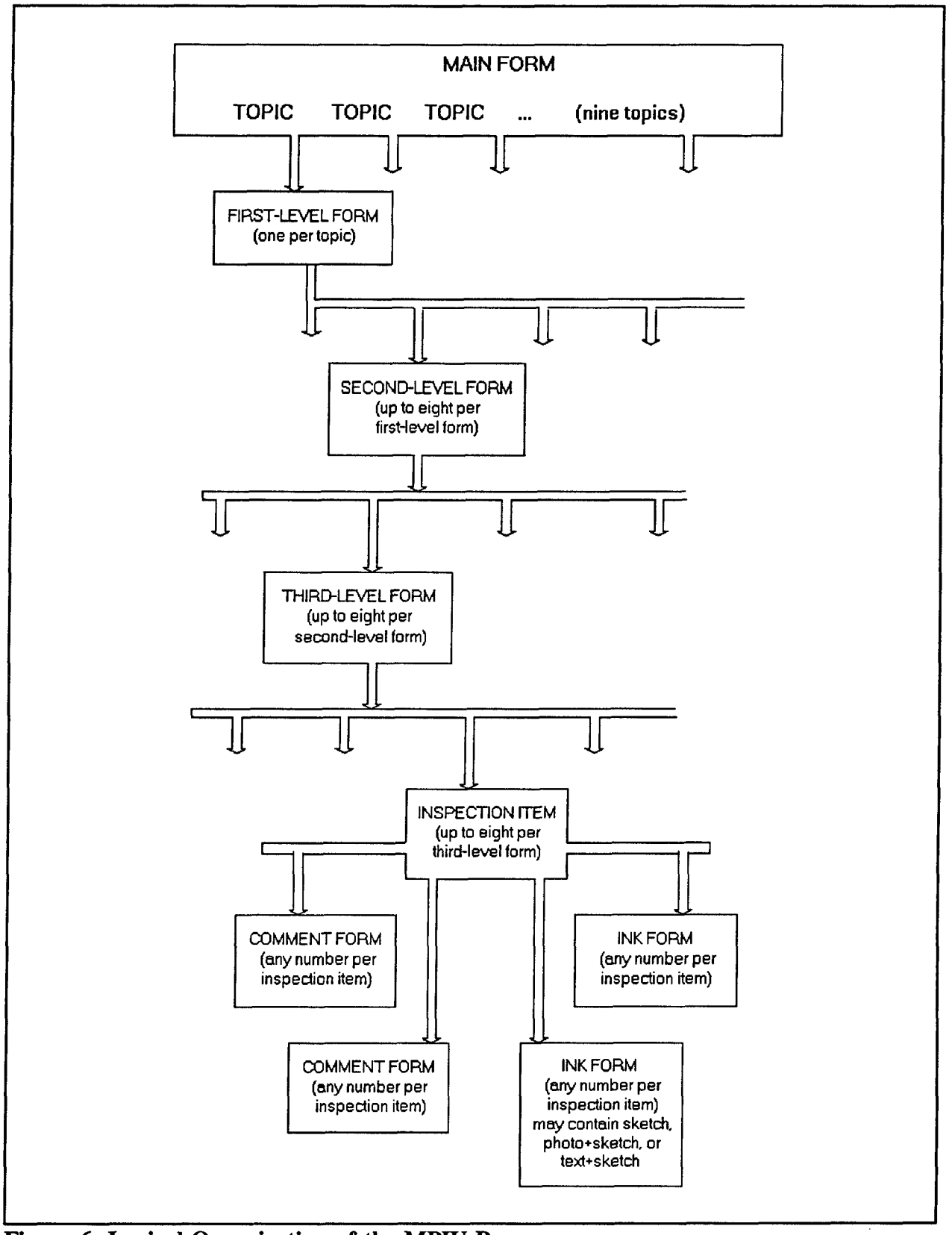

Figure 6 Logical Organization of the MPIU Programs

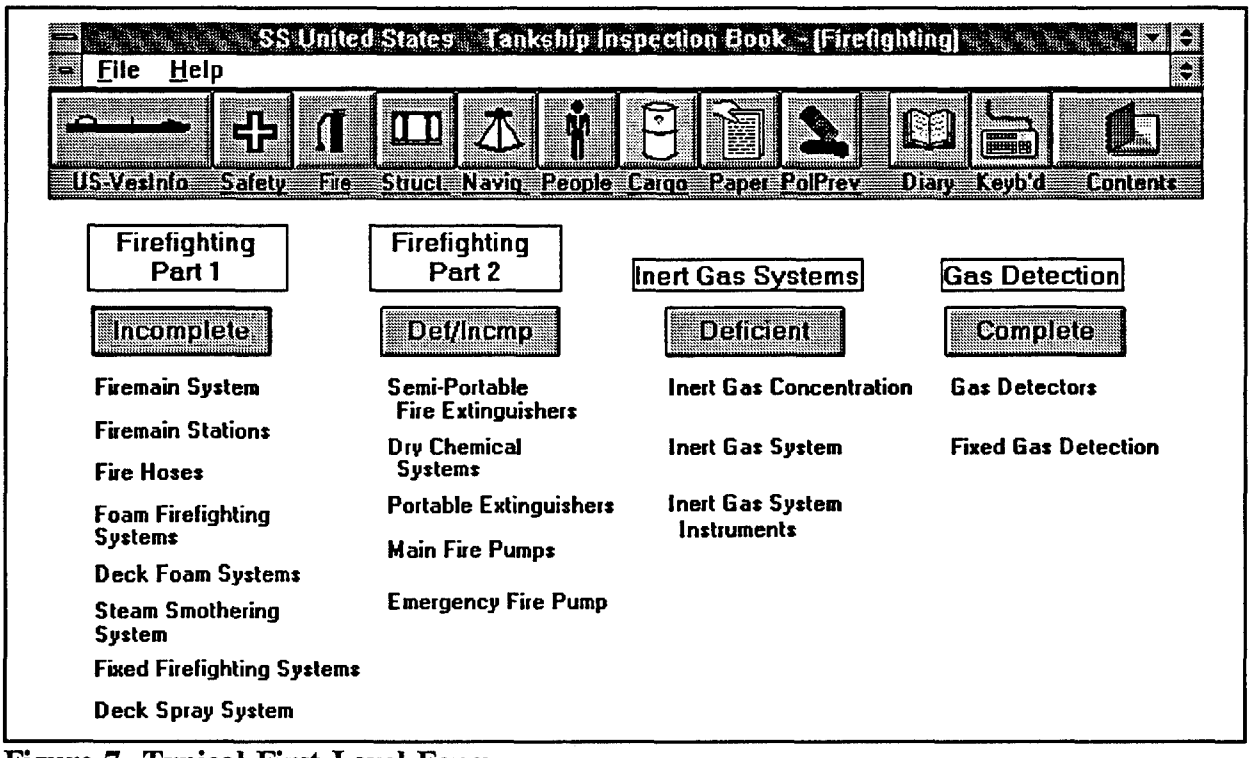

Figure 7 Typical First-Level Form

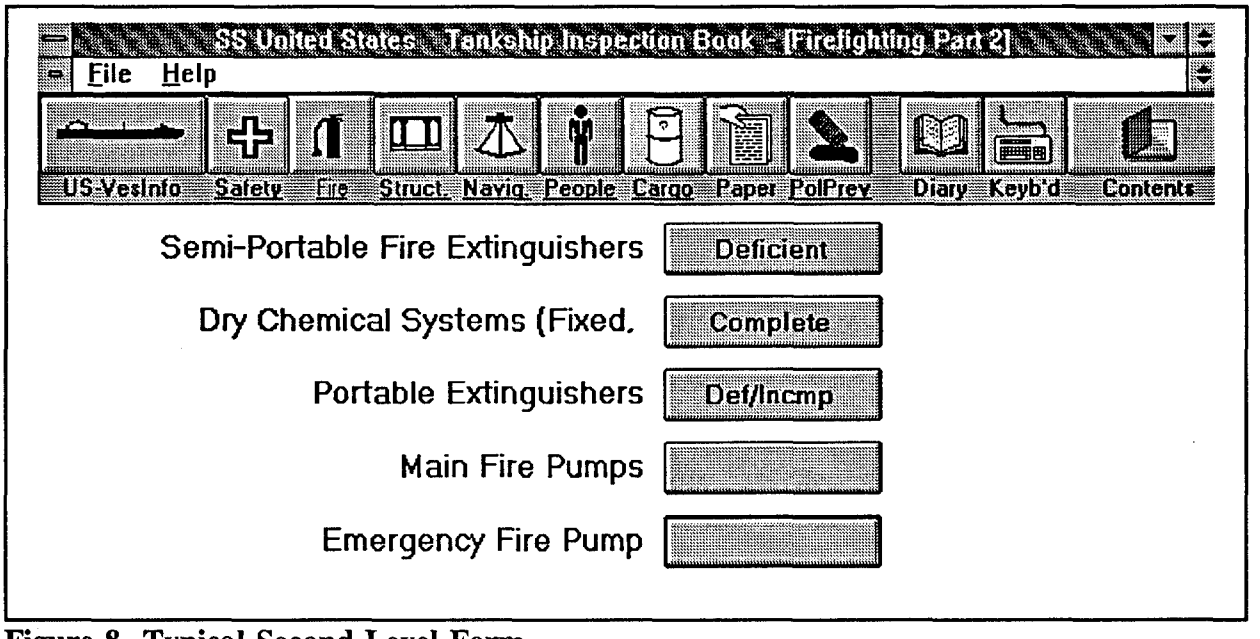

Figure 8 Typical Second-Level Form

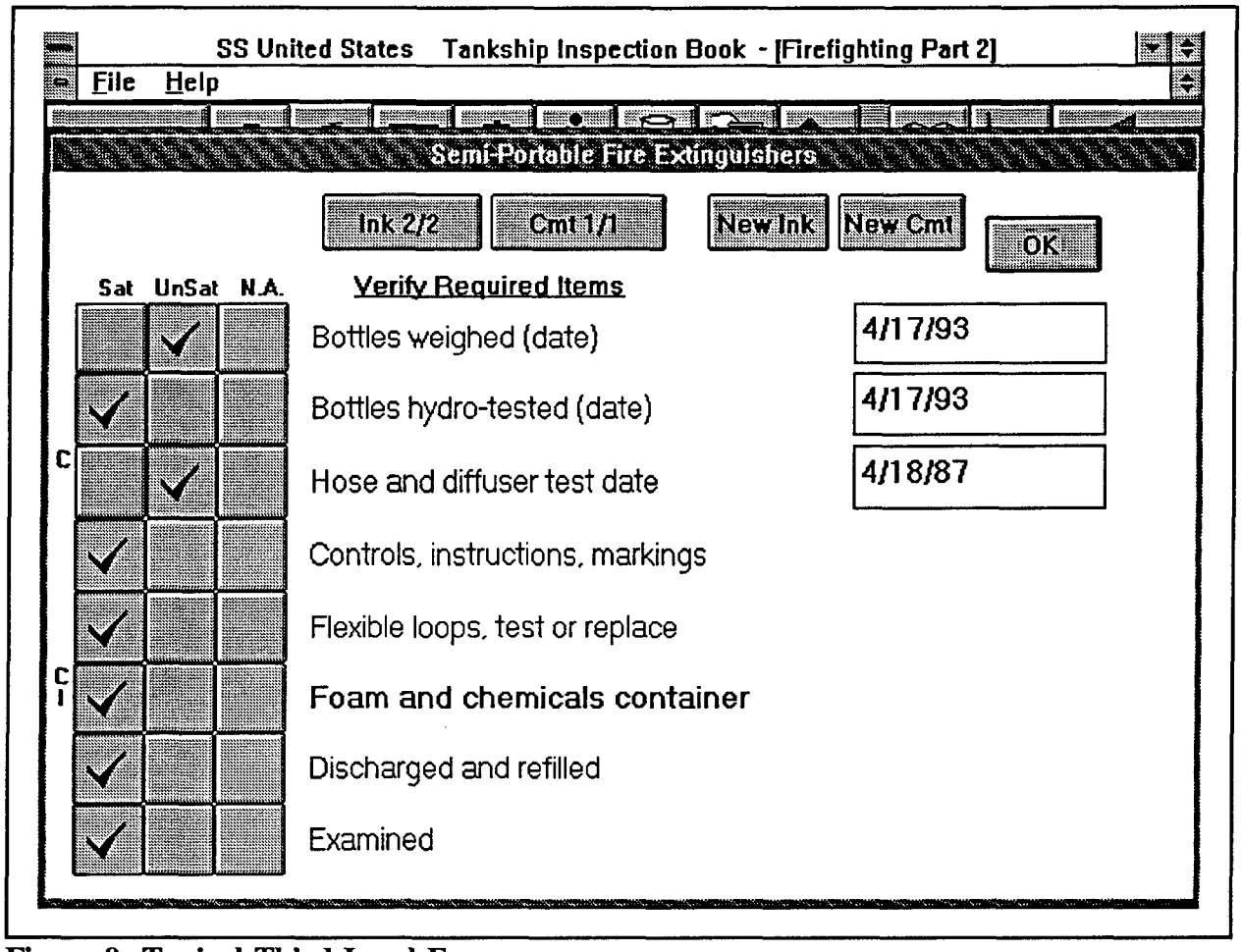

Figure 9 Typical Third-Level Form

3.2.3 The Evolution of the MPIU Software

The inspection programs were initially designed to implement the inspection books as they were used in offices where inspectors marked or initialed every applicable item in the book to indicate that it had, in fact, been inspected, and made text comments or notes on the blank right-hand pages of the books for all deficiencies. The programs were designed to use "UNSAT" checkmarks as flags for locating deficiencies and for printing deficiency reports. When New Orleans was selected as the test site, the software was altered to use "open" comments as well as "UNSAT" checks to flag deficiencies for report generation. In New Orleans, inspectors do not use the inspection books, relying purely on textual descriptions for their inspection records. With this alteration, an inspector can ignore the checkboxes and only enter comments for deficiencies.

A recent G-MVI policy instruction, reference 6.3, requires inspectors to keep records of all deficiencies found during inspections, even if they are corrected before the completion of the inspection. Partly as a result of this policy change, the comment and reporting

functions were enhanced to allow the three distinct categories of comments. "Cleared" comments can be used as flags to generate reports of both outstanding and cleared deficiencies, in keeping with the new G-MVI policy.

3.3 Field Trials

The field trials were conducted at the Coast Guard Marine Safety Office (MSO) in New Orleans LA, beginning on March 21, 1994, and ending on July 6, 1994. Training sessions were held at MSO New Orleans on March 21.

3.3.1 Training Sessions

The contractor conducted a training session at MSO New Orleans on March 21, 1994. Approximately ten inspectors and administrative personnel attended a one-hour introductory session and two inspectors participated in the four-hour detailed training session which followed. A detailed User's Manual, Appendix A, was also provided for the inspectors use.

3.3.2 Use of the Systems During Field Trials

During the course of the field trials, approximately 15 inspections were conducted using the computer systems. These included inspections of U.S. and foreign flag tankships and of barges. Five different marine inspectors from the New Orleans office used the systems during the trials. Three of these inspectors were trained to use the MPIU system by the two inspectors who attended the detailed training session.

3.3.3 Mid-Project Inspector Workshop

Edward McClave of MAR, Inc., met with LT Doug Ellis, LTJG Rob Nelson, and LTJG Jim Stewart at MSO New Orleans on May 17, 1994, to discuss the progress of the field trial up to that date. Up to that point, LTJG Nelson and LTJG Stewart had been the principal users of the MPIU system. LTJG Nelson had used the Dauphin DTR-1 system and LTJG Stewart had used the Compaq Concerto system. The inspectors offered a great deal of information about their experience with the systems, gave many suggestions for improvement, and discussed the overall concept of computer-assisted marine inspection. Mr. McClave clarified a number of points pertaining to the use of the inspection programs. Appendix B contains MAR's report of the results of this workshop.

3.3.4 Final Meeting at New Orleans

A final meeting was held on July 6-7, 1994, at MSO New Orleans. Marine inspectors from the New Orleans office who had used the MPIU systems were interviewed by Mr. Edward McClave of MAR, Mr. Bert Macesker of the R&D Center (the Contracting Officer's Technical Representative (COTR) of the MPIU project), and Mr. John Hannon of G-MVI (the project sponsor). LTJG Rob Nelson, LTJG Jim Stewart, and LTJG Todd Schoenfelt were

interviewed in the morning session and CWO Joe Grimes was interviewed in the afternoon session. Human factors personnel from the R&D Center interviewed these inspectors and one additional inspector separately. A questionnaire was distributed by MAR during this meeting. The COTR also prepared a questionnaire. Three of the inspectors who used the system filled out and returned both questionnaires. The completed questionnaires were used, along with comments made during the meetings, in preparing section 4 of this report.

On July 7, LTJG Stewart and LTJG Nelson conducted a simulated hull inspection of a deck barge which was under repair at a shipyard. The pen computers were used during this inspection. The barge was drydocked at the time of this inspection. Mr. Hannon, Mr. Macesker, and Mr. McClave accompanied the inspectors and observed this inspection.

3.4 Evaluation

Section 4 provides the detailed user's evaluation of the MPIU system based on the limited technology demonstration. Some of these comments directly conflict with inspector's comments obtained in Phase I which encompassed many more inspectors than did the technology demonstration. Therefore, the limited scope of the technology demonstration must be kept in mind when interpreting these results.

Many valuable insights were provided concerning improvements to software and hardware for the MPIU system. As many of these improvements as possible should be implemented before a larger scale pilot project takes place. Of primary importance is the need for an interface between the MPIU system and the marine safety database. This is where the inspector's time can best be saved and will have the biggest impact in favor of the MPIU system.

The comments in section 4 are listed by topic area and have not been sorted with regards to their importance in evaluating the goals of the technology demonstration. Section 5 summarizes the user evaluation as it relates to these goals. These goals, as stated in the SOW, are repeated below. The goals were to:

1. Allow inspectors to evaluate the concept of computerized inspection data management and to document their feedback on how effective it is in streamlining the business of ship inspection documentation;

2. Evaluate the hardware and overall concept of computerized inspection data collection under a range of environmental conditions including adverse lighting conditions, temperature extremes, exposure to oil and other factors; and

3. Identify the extent to which carrying a portable computer affects an inspector's safety and mobility.

4 USER EVALUATION AND COMMENTS

Inspection documentation procedures in the New Orleans office (and in the 8th Coast Guard District in general) are somewhat different from the traditional methods based on the 840-series inspection books. However, the marine safety database interactions of New Orleans inspectors are typical of those throughout the Coast Guard.

In inspection offices which use the inspection books, the inspector fills out a book for each inspection. In many cases the inspectors carry a "rough" book in which they make their firsthand entries while making the rounds of the ship, and then fill out another "smooth" book back at the office, which becomes, along with the inspection diary, the official record of the inspection. In all offices where the inspection books are used, the inspectors must manually fill in several pages of vessel information, which is generally printed on the bridge record card and the COI. Most of this information is also available in the current marine safety database, in either the MICOI or MIPIP product sets, or both.

Most offices expect that inspectors will make notations in the inspection books to indicate that they have inspected the necessary areas and systems. In some offices, this is done by checking or initialling the square checkboxes for the numbered sections. In other offices, inspectors initial (or mark as "NA") every bulleted item in the numbered sections.

Inspectors using the books also prepare a diary of their inspection findings in text form. Depending upon the office, this may contain only information about which inspector conducted what part of the inspection and about what representatives of the vessel accompanied them. In other offices, the diary contains descriptions of deficiencies, duplicating or amplifying information contained in the inspection books, and it may also contain text to indicate that certain areas and systems were inspected and found to be satisfactory. The diary, or excerpts from it, may be entered into the Narrative Supplement (MINS) product set of the current marine safety database.

MSO New Orleans abandoned the use of inspection books as the official record of inspections before the MPIU technology demonstration. While the inspectors there often carry the inspection books with them for reference, the inspector's text diary serves as the official record of inspections conducted at New Orleans. Inspectors enter their inspection diaries into the Narrative Supplement (MINS) product set of the marine safety database.

A typical MSO New Orleans inspection record of a vessel with no or only a few deficiencies may consist of only a few paragraphs of text, much of it standard phrases, along with the inspector's signature.

The MPIU software was originally designed and programmed to implement a more or less traditional inspection based on the inspection books. It was altered to be more compatible with the procedures used in New Orleans, but it is still based closely on the inspection books.

4.1 Use of MPIU System During the Technology Demonstration

This section describes the extent of usage of the hardware and software components of the MPIU systems during the New Orleans Field Trials.

4.1.1 Inspections Conducted Using the MPIU System

In all, five different inspectors conducted 5 inspections of tank vessels and 10 inspections of barges during the course of the technology demonstration. Several foreign tank vessels were among the vessels inspected.

4.1.2 Use of the Hardware by Inspectors

Both pen-based computers were used extensively. Inspectors generally carried the digital cameras with them, and were enthusiastic about the potential benefits of digital photography, but they apparently took very few photographs during actual inspections. Review of completed inspection files remaining on the two pen-computers after the project indicated that there were only a few photographs taken during inspections.

The laptop computer, the printers, and the CD-ROM drives received little, if any, use. There is certainly not enough information available to evaluate these components of the system. The only use of the printers was at the inspection office, and several inspectors indicated that it was difficult to carry the entire system with a printer to a ship along with their personal gear. The inspectors felt that the CD-ROM drive was too bulky to carry on board a vessel (the particular drive supplied was heavy and bulky - smaller, lighter CD-ROM drives are becoming available, and may soon be built into laptop computers).

4.1.3 Use of the MPIU Tankship and Barge Inspection Programs

Review of completed inspection files on the computers at the end of the project revealed that there was very little use of sketches, digital photographs, comments linked to individual inspection check-off items, or the MPIU program's rough diary.

The interviews with inspectors who used the software indicated that they made very little use of the report-printing functions of the software. At least one inspector indicated that the ability to print deficiency reports and worklists would be useful, apparently not realizing the report-printing function of the existing program was designed do just that.

The inspectors did not have occasion to conduct multiple-computer inspections of the same vessel, so the merge capability of the software was not needed, used, or evaluated. The Table-of-Contents and Help functions of the software appear to have been little used. More extensive use of these functions could have prevented or alleviated several of the problems cited by inspectors who used the system.

4.1.4 Use of the Supporting Software

ZYIndex

The ZYFind module of ZYIndex, the program which provided access to the on-line reference materials, received very little use during actual inspections. Some inspectors did experiment with this program. Despite the lack of actual usage of on-line reference materials, most of the inspectors interviewed felt that providing access to reference material was one of the most attractive potential features of the inspection computer system. With tighter integration between the inspection program and the reference database (i.e. context-sensitive reference access), this feature would most likely be used more heavily.

Interlink

Inspectors made very little use of direct file transfers from one machine to another through the MSDOS utility Interlink. The primary use of Interlink was expected to be in connecting the Dauphin pen-based computer (which does not have a floppy drive) to its base station, the IBM laptop computer, for merging, editing, or printing of reports. Since no merging or report printing appears to have been done, and since marine safety database entries had to be made manually, the ability to connect computers directly by cable, provided by Interlink, was not used.

FieldNotes

FieldNotes was included with the system primarily as a demonstration of capabilities, rather than as working part of the MPIU system. It was not used by any inspectors in actually conducting inspections.

RuleFinder

RuleFinder was included in the system as a CD-ROM disk. At least one inspector experimented with it, but there was not sufficient use to evaluate its potential as a component of the MPIU software.

4.2 User Evaluation - MPIU Concept

This section describes the information and evaluations which were provided by the inspectors who used the MPIU system during the mid-project inspector workshop on May 7, during the final evaluation session on July 6-8, and in various telephone conversations between MAR and MSO New Orleans inspection and training personnel.

4.2.1 Time Required to Conduct Inspections

If inspectors are to enthusiastically accept the concept of computer-assisted marine inspection, the system must either save them time compared to the manual method or must decrease the weight and bulk of the equipment and reference material which they now carry with them.

In general, the inspectors who used the systems indicated that they did not believe a computer system would save them any time in the actual recording of inspection data, whether data entry was done on-scene, in an office on the ship, or at the inspection office. However, there are two specific areas in which inspectors unanimously believed that a computerized inspection system would help. The first of these areas is their interactions with marine safety database. The second area is access to reference materials. In this phase of the project, no interface with the marine safety database was provided. The amount of reference material provided with the systems was limited and the means of access to that reference material was limited to a word-searching file indexing program which was not closely integrated with the inspection programs. Therefore, the inspectors found that, overall, conducting an inspection with the MPIU pilot systems actually took more time than the old paper-based method.

All of the inspectors who used the system found that it took longer for them to document an inspection using the computer system than it had using their manual methods. There are several reasons noted for this increase in documentation time:

Learning the System The inspectors who used the system were learning it as they used it. No inspector conducted enough inspections with the system to become as familiar with it as they were with the paper inspection books. A significant fraction of the time spent using the computer system, even when it was used on-site, was actually training time, rather than normal use.

The New Orleans Inspection Documentation Procedures The MPIU system was designed and programmed to implement the traditional method of inspection, based on the inspection books. In New Orleans, the entire record of the inspection is a text narrative, and the indication that certain systems were checked is done with a few sentences of more or less standardized text. For inspections where no deficiencies are found, the entire record of the inspection may be a few paragraphs of narrative with the inspector's signature. Using the computerized system required more entry of information by the inspectors in New Orleans than they usually do in a manually documented inspection.

A Lack of Previous Inspection Files or Marine Safety Database Interface In offices using traditional inspection documentation procedures, inspectors enter quite a bit of vessel information and specifications in the book at every inspection. Most of this is available from the marine safety database, but it must still be entered manually into the

book for each inspection. The inspection programs did not include a marine safety database interface, so this information could not be loaded into the program automatically as is planned for the future. The software, in its present state, does allow most non-volatile vessel information to be carried over automatically from the files of previous inspections of the same vessel. Of course, since this was the initial use of the software, there were no previous inspection files available. Each inspection done in New Orleans, therefore, was done as if it were an initial inspection for certification, in terms of the entry of vessel information. In New Orleans, where inspectors do not use the books and therefore do not enter vessel information for every inspection, entering this data was an additional task. This contributed to the inspectors' conclusions that using the computer required more data entry and took more time than their normal methods.

Most of the inspectors felt that entry of the inspection data into the computer on-scene would most likely increase the on-board time required to document an inspection compared to the traditional paper-based inspection book method. However, they generally agreed that the data would be more accurate and more complete if entered on-board, and that if the computer system could reduce the marine safety database interface time, the extra time spent on the vessel would be offset by the streamlining of office functions and would be justified.

Inspectors would prefer to spend more inspection time actually on board the vessel, and they indicate that this would improve the quality of inspections. If the computer system could reduce the amount of office time spent at the marine safety database terminal, and if a comprehensive reference library could be provided on the computer, a much greater fraction of the entire time devoted to an inspection could be spent on board the ship, and inspectors would leave the vessel with an essentially complete inspection record, ready for transmittal to marine safety database.

The first two inspectors who used the systems tried doing inspections in which they checked every "SAT/UNSAT/NA" button, and found that this greatly increased the time required to do an inspection, and that trying to ensure that all the checkmarks were checked distracted them from the task of inspection. These inspectors were initially under the impression that they had to check all of the boxes, which was not the case.

At the mid-project workshop, these inspectors indicated that the programs could be improved by allowing entire topics (i.e. firefighting, cargo, etc.) to be set to a default state of "SAT", which would allow them to concentrate their time on deficiencies, rather than on making "SAT" or "NA" checkmarks in every box for items which are not deficient. This change could be implemented easily. Another possibility would be to eliminate the checkboxes entirely and to use only comments to indicate deficiencies. This would correspond to the practice used in many inspection offices, where the inspector is only required to actively check off the square checkboxes; the bulleted items are used as memory joggers only. The more experienced the inspector, the less important they considered the checkboxes. In general, inspectors would prefer not to have to take action to indicate

satisfactory conditions; they prefer to concentrate on finding and recording deficiencies. Many inspectors do not feel they need or use the memory joggers, either as bulleted items in the inspection books or as checkbox items in the inspection programs.

4.2.2 Distraction from Inspection Tasks

The most important overall reaction of inspectors, which was unanimous with all inspectors who actually used the systems, was that using a pen-based computer while walking around the vessel distracted them both physically and mentally from their basic task of evaluating the condition of the vessel. All of these inspectors, after having tried using the systems as carry-around data collection devices, decided that the computers were better left in a shipboard office where they would be secure, and safe from damage and where they would not interfere with an inspector's concentration or mobility.

Part of the reason for the inspectors' conclusions that using the computer systems while walking around is distracting is certainly due to their short experience with them. In most cases, the inspectors who used the systems were learning to use the systems and learning to adapt to the concept of computer-assisted inspection at the same time that they conducted actual inspections. The technology demonstration did not last long enough for any inspector to achieved enough proficiency to evaluate the use of the systems independently of the added distraction of learning to use them. The constant fear of dropping and breaking or otherwise damaging fragile and expensive equipment adds to the distraction factor.

Despite the negative feedback about mobile use of the computers, future development of the computerized inspection concept should not preclude the possibility of using the computers in mobile mode. This means selecting pen-based hardware that functions well in the laptop mode preferred by inspectors but which is light enough and small enough that it can be used in mobile mode by those inspectors who prefer to use it that way and in those situations in which they feel it would be beneficial to carry the computers. It is expected that as inspectors gain familiarity with the concept and proficiency with the software and hardware, they will find more occasions for mobile use. Such functions as freehand sketching and graphical annotation of photographic images are most easily done with pen-based systems.

4.2.3 Carrying a Pen-Computer

Most of the inspectors felt that an inspection computer would be used primarily in an office aboard the vessel being inspected or, in the case of smaller barges inspected in shipyards, in an office in the yard. However, they would like to retain the option of carrying the computer around the vessel. With a computer of any size, this would require some kind of carrying bag or harness that would leave the inspector's hands free for climbing, which would not impede movement through tight access openings, but which would allow the computer to be accessed quickly, then put away again quickly.

In the early stages of the project, several inspectors carried the pen-based computers into cargo spaces, pump rooms, and into machinery spaces. However, after initially trying and evaluating the computers as on-scene data collection devices, they decided that this was impractical and they subsequently used the pen-computers in a shipboard or shoreside office.

The inspectors interviewed did not agree on the best way to carry a computer. A chest harness and a carrying bag slung over the shoulder and somehow secured to the inspector's body are the most common suggestions. The inspectors who used the system tried the prototype chest harness which was provided by the R&D Center. Their general reaction to carrying the pen-computers was that they preferred not to carry them in any space except open deck areas, so they had little use for a carrying harness. They indicated that even with a carrying system which was specifically designed for the particular computer and for the application, they would be unlikely to carry a computer while inspecting most shipboard spaces.

4.2.4 Standardization of Inspection Procedures

Even the least experienced inspectors were conscious of the value a computer inspection system could have in standardizing the way inspections are conducted from one inspection zone to another. All inspectors are concerned that if inspection procedures and standards differ too much from one area to another, vessel owners will be tempted to "shop around" for the best deal. This situation creates additional problems when a vessel moves to a different inspection zone and conditions which were accepted by the previous zone are considered deficient in the new zone, or vice versa. The 8th District, for example, has abandoned the use of the 840-series books, partly because they are out of date and do not incorporate many recent regulatory requirements. While the inspectors there are well aware of the need for updating the inspection requirements, they are also aware of the advantages of uniform inspection policies throughout the Coast Guard, and they feel that a well-done computerized inspection program could help achieve a high level of standardization.

4.2.5 Concerns About Industry Reaction to Inspection Computers

The issue of the industry's perception of computerized inspection was raised. At least one inspector was concerned that a marine industry dominated by "old-timers" would interpret Coast Guard inspectors' use of computers to be an indication of inexperience, and that the civilian with whom the inspectors must deal would think that the computer, rather than the inspector, was conducting the inspection.

There has been little opportunity to evaluate this concern. However, during the ship inspection phase of the New Orleans evaluation session, conducted in a very "low-tech" shipyard, a yard worker who happened to be working on the barge on which the computer-assisted inspection was being conducted was asked about his reaction to the inspectors carrying computers. He pointed out very clearly, and without prompting, that he considered the inspectors' computers to be only tools, and that recording inspection data on the spot,

rather than later, from memory, and without transcription, could only improve its accuracy. He obviously did not perceive the use of computers as a crutch to compensate for a lack of inspector expertise.

4.2.6 Security Issues

The physical security of computer equipment aboard ship or in a shipyard is a potential issue, especially considering that inspectors will have to leave at least part of the equipment unattended while making the rounds of the vessel. Protection from both theft and from weather are concerns. Inspectors did not anticipate that security would be a problem on board either U.S. or foreign vessels, except possibly when a large number of shipyard workers were aboard. In general, on tank vessels, a secure space such as a stateroom or ship's office or a shipyard office is available. The inspectors did express concern about security on some overseas inspections, both in shipyards and in transit, and pointed out that on many barges there are no suitably secure office spaces available.

4.2.7 Additional Information Which Should be Available in a Computer System

The marine safety database does not contain information about variances and letters of exemption which have been issued to vessels in the past, and which are still in effect. These records are presently kept only in paper form in the vessel's port of registry, and in some cases are difficult to locate when needed. This is a particular problem when a vessel changes inspection zones or when it is inspected in a zone other than that in which it is registered.

One experienced inspector, who had obviously dealt with such problems in the past, suggested that having the records of such exemptions (possibly the actual text of the letters) available in the computer inspection files would be an improvement over the present paper-based system for keeping such records.

4.2.8 Template Drawings

During the previous work that led to the MPIU project, inspectors often commented that it would be very helpful if the drawings of the vessel being inspected were available on an inspection computer system for reference during an inspection. During the course of the field trial, and as a result of discussions with inspectors about techniques for recording structural deficiencies in tank vessels, the contractor prepared a 3-dimensional drawing of a typical tank vessel's hull construction. A number of overall and detailed perspective views were produced from this drawing and were used as background templates for ink forms in the tankship program. Some inspectors who saw these felt that they might be a valuable addition to the system, while others thought that only accurate drawings specific to the vessel being inspected would be useful.

If such general templates were to be used, some simple changes in the program would be necessary. Presently, only background images (such as digital photographs) which are

stored in a specific vessel's inspection directory are available to ink forms as background. The software would have to be altered to allow general template images to be available to all inspections.

4.2.9 The Need for an Auto-Save Function

There was at least one occasion in which a significant part of an inspection file was lost because of an unexpected (and unexplained) system shutdown. This could have been prevented, or at least minimized in scope, by the inclusion of an automatic timed save feature in the inspection programs. This change could be made easily, and the user could have the option of choosing the frequency of the automatic save. However, the user should probably not have the ability to turn off auto-saves altogether. Saving even a very large inspection file takes only about 10 seconds on the present hardware, and this will improve as the hardware technology advances.

4.2.10 Additional Forms

Inspectors often have to issue various paper forms to vessel owners during or after an inspection. Carrying these forms can be troublesome and filling them out can be time-consuming. It would be helpful if the computer system were able to print out most of the commonly used forms, such as temporary Certificates of Inspection, Permits to Proceed, SOLAS certificates, MARPOL certificates, etc. A good deal of the information which is presently entered manually on these forms by the inspector will be available in the files uploaded from marine safety database at the beginning of the inspection, and could be used to automatically fill many of the fields on the forms. The remaining information could be entered by the inspectors into the computer, and then the forms could be printed out on-site for signature and issuance.

4.3 User Evaluation - Hardware

4.3.1 Equipment Evaluations

Most of the equipment problems experienced by the inspectors were based on the difficulties of managing multiple battery-powered devices. Both of the pen-based computers have multiple, and often confusing, power management settings, and these controls for these differ from one machine to the other. The battery lifetimes of the computers and the cameras are different, which adds to the confusion.

Dauphin DTR-1

At least one inspector felt that the screen of the Dauphin computer was too small to be useful. However, all the inspectors did not comment on this. If this screen is, in fact, too small to be practical, then a pocket-sized data collection and management device may not be useful in the general sense, even if the volume and weight decrease as technology advances.

Problems with the Digital Cameras

There were problems connecting the digital cameras to the computers. It was determined later that the support software for the two cameras differed slightly, and this was the reason for this problem.

The camera battery state can only be determined when the cameras are connected to the computer, which makes it difficult to plan camera usage. The power usage of the cameras depends primarily on flash usage, which differs greatly depending upon the ambient lighting, so it is not possible to monitor battery condition solely on the basis of the number of pictures taken. It would be very helpful to have a shot counter and a battery condition indicator on the camera.

Unexpected Resets on the Dauphin

It was found near the beginning of the project that the Dauphin pen-based computer would reset if the user's hand touched the port connectors on the side of the case. these connectors are covered by the slide-on protector during normal mobile operation, but this cover must be removed whenever any external cables are plugged in, exposing the port connectors.

Visibility in Bright Light

Both the Compaq and Dauphin screens are difficult to see in bright outdoor lighting conditions. This is a particular problem on barges, where most of the computer use is likely to be on deck if the computer is brought to the vessel.

Tethered vs. Untethered Pens

Both the Dauphin and the Compaq pen-based computers had untethered pens. None of the inspectors interviewed indicated that there was a problem with dropping or losing pens. However, the computers were not used heavily in difficult locations.

4.3.2 Use of Equipment in Hazardous Locations

None of the electronic equipment used in the MPIU Pilot Study was approved for use in hazardous locations. There are a number of locations on crude oil and product tankships, chemical tankships, and tank barges where approved equipment may be required. Most inspections of U.S. tank vessels and of most barges take place in repair yards where most of the ship or the entire ship has been gas-freed, and thus approved equipment is not required. Inspections of foreign tank vessels and of mobile oil drilling units (MODUs) may require approved equipment in certain locations.

Locations where inspectors might go during inspections which require approved equipment are the cargo pump rooms of tank vessels or barges and the drilling floors of MODUs. Perhaps the most likely place inspectors might run into the requirement for approved equipment is on the main deck of petroleum and chemical tankships and barges. The presence of cargo tank vents on deck necessitates the use of approved equipment on such vessels while they are carrying cargo or when empty tanks have not been gas-freed.

The New Orleans inspectors did have at least one occasion on which the requirement for approved equipment prevented use of part of the MPIU system - one inspector wanted to take some photos on the deck of a chemical tanker, but could not because the camera was not intrinsically safe.

The inspectors were asked whether the requirement for approved equipment might prevent them from taking the equipment aboard a vessel, even if the only use was to be in a temporary office on board. They indicated that this was very unlikely to create a problem.

4.3.3 Power Supplies, Battery Chargers, and Cabling

The large number of power supplies and power and data connection cables needed to operate the fully configured MPIU system with a printer, a CD-ROM unit, and a camera is somewhat daunting and confusing. The inspectors repeatedly mentioned the difficulty of managing the charging of batteries in multiple devices, all of which use different chargers and have different charging times and battery lives.

The large number of cables was a source of intimidation for inspectors using the system, and particularly for those learning it. Most of the cables provided were of standard lengths, which in most cases, are longer (and thus bulkier, heavier and more prone to tangling) than are required for a system intended to be used in a small area.

4.3.4 Durability of the Hardware

Despite their misgivings, several inspectors did attempt to use the pen-based computers in spaces such as ballast tanks, voids, and cargo tanks. However, they quickly abandoned using computers in difficult spaces because of fears of damaging the hardware and because of the difficulty of carrying the computers while climbing and crawling. Therefore, the hardware (particularly the pen-based computers) did not receive a rigorous test of durability or resistance to environmental factors.

However, both pen-based computers were carried on board ships and barges, and at the end of the project, they were both unscathed with the exception of a small crack in the case of the Compaq. No pens were lost, even though the pens for both units were untethered. The glass screens showed no signs of scratching. (Pen-computers generally have glass screens because of the embedded pen-sensing electromagnetic digitizers, while laptop computers generally have plastic screens. The screens of pen-computers are therefore much more

resistant to scratching in dusty and dirty environments. For this reason alone, pen-computers are preferable to standard laptop computers in rough environments.

The digital cameras were carried extensively on board vessels to a much greater extent than the pen-based computers. They suffered no physical damage and proved to be very durable. The rechargeable battery of the FotoMan Plus camera had corrosion on its outside connectors and would no longer hold its charge by the end of the project.

The other hardware (laptop computer, CD-ROM drives, and printers) were not used outside of protected locations. These suffered no damage.

4.4 User Evaluation - MPIU Inspection Programs

4.4.1 Focus on Details

One particularly well-stated criticism of MPIU programs, from the most experienced inspector who used the system, was that the emphasis on checkboxes for individual inspection items forced inspectors to start with the details, rather than allowing them to get "the big picture" first, and deal with details of deficiencies later. This inspector very firmly believed that the inspector's overall impression of the vessel was more important than the details, and that using the computer interfered with the process of gaining an accurate overall impression of a vessel's condition.

4.4.2 System-Based vs. Compartment-Based Software Organization

The two principal strategies for organizing the appearance of either paper-based or computer-based recording of inspection data are the system-based and compartment-based strategies. The system-based organization keeps all elements of a given system, such as firefighting, cargo handling, or hull structure together either in terms of pages of a book or screens of a computer program. Thus, each individual item, such as lifejackets or fire hoses, appears on only one page in the book or on one screen of the program. The CG-840 series inspection booklets use a system-based strategy. The alternative, a compartment-based organization, keeps all entries necessary for a given shipboard space together. Thus, items such as life jackets or fire hoses appear many times, once for each space in which they might be found.

Inspectors generally conduct their inspections by spaces or compartments rather than by systems. In each compartment, they thumb through the book to record deficiencies or to make comments about equipment belonging to the different systems in that compartment. Because the book is small and the inspectors know the physical position of the sections for each system in the book, this method does not present a problem.

During the interviews for Phase I, inspectors were asked whether a compartment-based organization or the present system-based functional organization of the inspection books was

best for a computer-based inspection system. Inspection offices were specifically requested to make their older, more experienced inspectors available for these interviews, so the opinions obtained tended to be those of older, less computer-literate inspectors, who had long experience using the inspection books. During these interviews, there were some inspectors in favor of each strategy, with a slight majority (mainly the older inspectors) preferring the system-based inspection. As a result, the tankship and barge programs were written with a system-based interface which closely replicated the organization of the inspection books.

It should be noted that the system-based strategy is much easier to program and makes storing the recorded data easier than does the compartment-based scheme.

4.4.3 Inspectors' Evaluations of the System-Based Strategy

The inspectors who used the MPIU found that the system-based organization made it difficult for them to record inspection results, especially in spaces like the bridge of a large vessel, which contain equipment or other inspectable items belonging to many different systems. As was stated above, the experienced inspectors who were interviewed during the first phase of the project indicated that they preferred a system-based organization. When this was implemented and tested, however, the users clearly indicated that a compartment-based strategy would have been easier to use.

Part of the problem which inspectors had with the system-based approach is undoubtedly due to a lack of familiarity with the program; however, the contrast between the older inspectors' expectations and the users' findings reveal a fundamental difference between the capabilities of paper-based and computer-based inspection systems. The material in the book, besides being organized functionally, is also organized spatially. An inspector who knows the organization of the paper book knows the approximate physical location of the desired section in the book, and can flip through the pages in a second or two to locate a given section. Even if the inspector is not completely familiar with the book, it is possible to flip through the pages serially and visually scan the contents to find the required section in a few seconds or less. With the hierarchical organization of the inspection programs, the limited amount of information that can be displayed on a single screen, the rewrite delay between screens, the requirement to take action to effect each screen change, and the large number of screens in each program, it would take minutes for an inspector to flip through the screens to find a particular section.

The Table of Contents control built into the inspection programs could have helped inspectors to navigate more easily from one section to another, and could have compensated for their lack of knowledge of the organization of the program. The Table of Contents control intentionally reflected the organizational structure of the paper inspection books, not that of the program. Inspectors apparently did not use this function extensively.

4.4.4 Combinations of Compartment-Based and System-Based Strategies

One inspector suggested that while on the vessel, a compartment-based strategy made more sense, since it reflected the way an inspector actually moved about the vessel, but in the office, filling out the final record of the inspection, a system-based organization made more sense. This, in fact, would very likely be the strategy of the inspection programs if they were adapted to a compartment-based user interface. Even though the material was presented in compartment-based form to the inspector, eventually all of the information for a given system would have to be merged into one coherent record. Thus, it is likely that the compartment-based organization would be a user interface for an underlying system-based data storage scheme. The vessel information and deficiency sections of the marine safety database are system-based, so the inspection data would eventually have to be placed in this format for downloading to the marine safety database.

4.4.5 Marine Safety Database

Some inspectors expressed a concern that the computer inspection system would present another hard-to-learn computer system in addition to the marine safety database, thus requiring inspectors to become familiar with two different systems to do their work. Their primary conception of the marine safety database is as a system which placed increased demands on inspectors' time, decreased the time available for actual on-board inspection work, and was difficult to learn, without providing any tangible benefits to the inspectors in the field. They are concerned that a computer inspection system might place further demands on their time, might have a user interface completely different from the marine safety database, and might further infringe on actual inspection time, again, without tangible benefits. In general, inspectors felt that for a computer system to improve the field inspector's situation, it would have to be very closely integrated with the marine safety database and would have to automate much of the marine safety database work they now do manually.

The inspectors pointed out that the marine safety database access is slow and that most of the demand for marine safety database access in the inspection office is early in the morning and late in the afternoon. They indicated that a computer system could improve the situation if some of the work now done in front of the marine safety database terminals could be done on the portable computers and the actual interaction between the inspection computers and the marine safety database could be performed automatically, either in the middle of the day or at night, without the inspectors' presence being required and without competing for valuable morning and afternoon marine safety database access time.

4.4.6 Handwriting Recognition

The inspectors had surprisingly little to say about handwriting recognition with the pen-based computers. The records of inspection conducted with the computers indicate very little use of comments or the built-in diary in the MPIU inspection programs, indicating that the inspectors avoided entering text with the pen. One inspector who used the system quite a

lot commented that the recognition improved as he became more practiced, which is also the experience of the authors. Several inspectors commented that certain letters which they tend to form in non-standard manners caused continual problems. The Microsoft Alphanumeric Recognition System (MARS) of Windows for Pen Computing uses not only the final shape of letters, but the order of the strokes used to form them as factors in recognition - when letters are formed in a non-standard manner, as they often are by left-handed people, there can be difficulty. The system can be trained to a certain extent to recognize non-standard shapes and strokes. This is time-consuming but it only has to be done once to customize recognition software for an individual.

4.4.7 Experience-Related Factors in the Evaluation of the Inspection Software

One fairly junior inspector trainee who used the system thought that additional on-line information should be provided to assist an inspector in deciding whether an individual inspection entry should be checked "SAT" or "UNSAT". While all of the inspectors, as well as MAR, R&D Center, and G-MVI personnel agreed that direct context-sensitive access to reference materials from within the program was desirable, this inspector felt that another entire level of "memory-jogger" items beyond the check-box level would be helpful, and that some sort of pop-up help, in addition to the text of the reference materials, was needed for each individual check-off item.

The more experienced junior officers did not see a need for more detailed guidance, beyond context-sensitive reference access, at the check-off level. The one very experienced warrant officer felt that the check-off items themselves were unnecessary. He preferred to be able to check off entire systems, such as firefighting and cargo handling, with a single stroke of the pen, and felt that entry of data into the program should be limited to explanations of deficiencies only.

The inspectors who tested the MPIU system indicated that their experience with computers in general and with Windows in particular ranged from "beginner" to "highly proficient". The older and more experienced inspectors had less proficiency with computers.

4.4.8 Software Details

It was suggested that a "Not Observed" category should be added to the existing "SAT/UNSAT/NA" checkboxes. This would account for spaces which were not available for entry, systems which were under repair and could not be tested or inspected, etc.

4.4.9 Supporting Software

The supporting software received very little use during the MPIU pilot study, and therefore the inspectors' evaluations of these programs were not very comprehensive.

ZYFind

Inspectors who used ZYFind found that text searching access was of limited value as a reference access technique. Table-of-Contents (hierarchical) searching would have been more useful. The lack of direct access from the inspection programs to the reference material clearly inhibited the inspectors' use of the search software. All of the inspectors who commented on reference access felt that direct context-sensitive access to the reference database from within the inspection programs was highly desirable. The limited scope of the reference materials provided with the MPIU system also clearly limited both the use and evaluation of this function.

Interlink

Interlink was primarily intended to allow inspection files to be transferred from the Dauphin pen-based computer to the laptop computer for editing or to the Compaq pen-based computer for merging of multiple-inspector jobs. The inspectors did not use the laptop computer, nor where there any multiple-inspector inspections, so Interlink was only used occasionally. Inspectors did complain about the inconvenience of having a number of power and data cables. The Interlink cable, which is much longer than necessary, certainly contributes to this problem.

RuleFinder

Lloyds Register RuleFinder (available from the Compaq only, when connected to a CD-ROM drive) was tried briefly by a few inspectors, but was not used as a reference source during any actual inspections.

FieldNotes

FieldNotes, like RuleFinder, was tried out primarily out of curiosity, and did not play a part in any inspections. Inspectors had few comments about this program. FieldNotes requires considerable practice and training, and the inspectors did not have the time to use it enough to evaluate its potential.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of User Evaluation

This section provides conclusions and recommendations for changes to the MPIU system requirements based on the development effort and the short technology demonstration at MSO New Orleans. As a result of the technology demonstration, the inspectors who used the MPIU system made many comments regarding improvements to the system. Not all of these have been recommended due to the limited scope of the demonstration. The suggested improvements could result from personal preferences of the few inspectors using the system. A more extensive evaluation of the hardware and software is recommended before general conclusions are drawn.

The development of the tankship and barge programs, the evaluation and acquisition of the hardware and commercial software for the two MPIU systems, and the MPIU technology demonstration at MSO New Orleans proved to be very instructive and represent a major step toward computerizing marine inspection data management. A number of features of the MPIU programs received more or less unanimous approval from users, including digital photography and on-screen sketching and annotating of photos and template images. However, some other features could be further developed and refined.

In general, inspectors were enthusiastic about the potential for computer-assisted inspection data management, and saw the systems and software provided during this project to be a useful first step toward achieving that potential. The users of the MPIU systems repeatedly stressed four principal themes: first, the need for a two-way interface between the MPIU system and marine safety database; second, that the system-based, checkoff-box oriented design of the MPIU inspection programs needs to be changed to a compartment-based design with more emphasis on recording deficiencies; third, that carrying a computer around a vessel during an inspection is impractical but having one available on board is very beneficial; and, fourth, that computerized access to reference materials is the most valuable function from the inspectors' viewpoint.

5.2 Conclusions Based on User's Comments

5.2.1 Computerized Inspection Data Management

The lack of a direct interface between the MPIU programs and marine safety database affected both the manner in which the inspectors used the MPIU software and their evaluations of the system, especially with regard to the time required to conduct inspections with the system. There was a built-in duplication of effort required, since any information the inspectors entered into the MPIU programs had to be re-entered manually into marine safety database if it was to become part of the inspection record. This discouraged inspectors from using comments or diary entries in the MPIU programs.

The inspectors using the system felt unanimously that it afforded no saving in time over paper-based data collection. It should be noted that the purpose of the MPIU system was not to save time on board ship but rather to save time back at the office when interfacing to the marine safety database. This feature was not part of the technology demonstration. Thus, the true savings that the MPIU system provides could not be evaluated by the inspectors.

Inspectors want the MPIU to be, essentially, an extension of marine safety database. They would like to have the ability to:

- Upload the information which they currently print out from the marine safety database into the computer with a minimum of on-line time for the inspector.

- Automatically fill in and print all marine safety database-related forms on board the vessel being inspected.

- Perform marine safety database functions such as deficiency coding on the portable computer system, in a more user-friendly environment than the current marine safety database provides.

- Download completed inspection data to the marine safety database, again with a minimum of on-line time for the inspector.

Inspectors should be able to perform on board the vessels, using their portable computers, most of the functions now accomplished at the marine safety database terminals in the office. Tasks such as coding of deficiencies should be done on the portable computer using pull-down menu picks and other enhancements. The transfer of vessel information and past inspection records from the marine safety database to the portable computers and of inspection data from the portable computers to the marine safety database should be streamlined to require as little office time and inspector interaction as possible. This will provide more time on board for inspections or allow a reduction in the inspection work force.

5.2.2 Hardware and the Overall MPIU Concept

Current Inspection Requirements

The inspection programs must reflect up-to-date inspection requirements, many of which are not included in the inspection books which date from the late 1970s. This requires starting with up to date inspection requirements and frequent updates to the programs as rules change. Also, major ship inspections include both machinery and hull inspections simultaneously. These are now in separate CG-840 series books. The MPIU system should combine all books related to a single ship type into one program.

Changes to Hardware

Users would like the hardware to be chosen to more closely reflect their actual needs. They recommend that the MPIU system:

- Abandon the carrying of a pen-based computer as a fundamental premise of system design. Base the system on a portable pen-capable system which is primarily designed for desktop use but which can be carried if desired.

- Provide a durable integrated system case with space and adequate battery power for the computer, the printer, and the camera.

- Continue support for digital photography, preferably in color, and streamline the transfer of pictures from the camera to the computer.

- Delete the little used CD-ROM from the system to reduce weight and complexity.

Again, these suggestions result from a limited trial and a limited number of inspectors. Further evaluation should be made before choosing an approach. The authors also feel that the CD-ROM drive can be eliminated since hard disk sizes on portable computers are rapidly increasing and all reference material can now be stored on the hard drive. A carrying case/portable office is a practical solution adopted by many people that have to travel frequently. Independent batteries will still be needed for each piece of equipment so that the camera and pen-computer could be used away from the office environment. However, a common power supply is a practical alternative. This supply should accept U.S. and foreign power inputs and supply EMI, RFI, surge and spike protected power to all units in the system via short power cords with appropriate terminal connectors. Some equipment requires DC power that would need to be rectified by the power supply and output at the correct voltage. The power supply should be flexible enough to accommodate reasonable changes in MPIU hardware from time to time. This power supply, along with a MPIU system carrying case with short connecting cables is believed by the authors to be a very practical addition to the MPIU system.

Changes to Inspection Programs

The users recommended three major changes to the MPIU inspection programs:

- The adoption of a compartment-based organization instead of the present system-based organization.

- A change in focus from checking off satisfactory items to recording deficiencies, including abandonment of the check-off boxes for individual inspection items.

- More visual and graphical assistance in navigating the structure of the program.

All three of these suggestions may have merit. However, it would be prudent to conduct a larger pilot project involving many more inspectors before drawing conclusions on these issues. Changing to a compartment based organization requires significant work to determine which systems are likely to occur in which compartments or even to determine generic lists of compartments for a given type of ship.

Classification societies have adopted checkoff lists to force their surveyors to verify items in detail. This was done to promote uniformity between surveys in different parts of the world. Their surveyors had much the same reaction to this change that the inspectors in New Orleans had to more detailed check boxes in the MPIU programs. The choice is really between allowing inspectors more discretion when evaluating systems overall or enforcing uniformity by requiring detailed checkoffs. This is a management decision that must be made before the final MPIU system is implemented.

The MPIU system already has alternate means of navigating quickly to selected topics. The problem of finding checkoff items rapidly is likely to decrease as inspectors gain familiarity with the programs. There were probably similar problems with the CG-840 series inspection books when they were first introduced.

Changes to Reference Material Access

Users were enthusiastic about the potential of the inspection computer system to facilitate access to the large volume of reference materials required by inspectors. However, they found little use for the simple word-search access to a limited database which was provided with the MPIU system. Reference access should be more fully developed, and the reference access and data collection functions should be more closely integrated, preferably by direct context-sensitive access to the reference material from the inspection programs. Additional reference material should also be incorporated including the Marine Safety Manual, NVICs, international rules, MVI policy letters, OCMI instructions, the equipment list, and possibly classification society rules. It would also be beneficial to include any waiver letters in individual vessel files.

5.2.3 Effect on Safety and Mobility

Inspectors did carry the pen-computers with them in some tank and machinery space inspections, but concluded early on that they preferred to keep the equipment secure in an office environment either aboard ship or in a shipyard office. Therefore, a thorough evaluation of the effect on safety and mobility was not performed and only limited conclusions can be drawn from the technology demonstration. The inspectors did feel that their mobility was adversely affected by carrying the computer and they did not like the chest harness method of holding the computer very well. However, the inspectors remain open to trying improved carrying systems and all agreed that they would use an improved system

when a mobile inspection was warranted. They were also afraid of damaging an expensive piece of equipment when maneuvering through tight spaces or climbing ladders. Inspectors did not consider the fact that the computer or camera was unsafe in hazardous locations to be a serious limitation.

In any future pilot study, it will likely be necessary to plan for a detailed test of safety and mobility rather than let the inspectors decide how they will use the system. Several means of carrying the computer should be provided during these tests to evaluate all possibilities under consideration.

5.3 Recommendations Based on the Technology Demonstration

5.3.1 Additional Field Evaluation

It is recommended that as many as possible of the changes discussed previously and in the following paragraphs be made to the MPIU system, followed by another, more extensive, field trial. This field trial should be conducted in an office where the current inspection procedures are still based on the inspection books. Training of inspectors by other inspectors did not work well in the New Orleans field trials; therefore, more time should be devoted to adequate training of all users before future trials.

5.3.2 Recommended Changes to the MPIU Hardware

Hardware Integration

Assembling a system (computer, printer, CD-ROM, cameras, etc.) in modular fashion from standard off-the-shelf hardware has many advantages in terms of flexibility, adaptability, and easy replacement and upgrading of individual hardware components. However, when most of the components are battery powered, the user must expend considerable effort and pay close attention to ensure that all batteries are charged at the beginning of an inspection and that spare charged batteries are ready when needed. The modular approach also requires a number of data connections, most of which require cables, and these cables are typically much longer and bulkier than necessary.

First of all, it is recommended that this modular strategy be maintained. The technology of portable computer equipment is progressing rapidly, and it is important that the obsolete or damaged components of the system can be easily replaced or upgraded without affecting the rest of the system. However, a higher level of hardware integration is needed to eliminate the number, size, and weight of chargers and cables. While no need for custom-designed computers, printers, or other important peripherals is anticipated, a carrying system with an associated combined power supply and short cables for connecting all equipment, should be specifically designed and built for marine inspection application. Because inspectors often board foreign vessels at sea, the carrying case should survive shocks over and above those which the individual components of the system are designed for.

Delete Requirement for a CD-ROM

The CD-ROM is no longer needed as a means of referencing large databases. The size of reference databases used routinely by the inspectors can be accommodated on computer hard drives now available. Therefore, this additional piece of equipment with its data cables and power supply should be eliminated.

Two Computer versus One Computer On Board

Based on inspector responses in the technology demonstration, future systems may not require both a small hand-held computer like the Dauphin and a laptop computer. Further field evaluation is needed to verify the inspector's preferences regarding computer size. If the larger pen-computer is preferred by the majority of inspectors, the inspection system could consist of one pen-based computer which can be hand-carried when the inspectors desire and can also serve as an office-based laptop computer with a keyboard and mouse. The latest model of the Compaq Concerto (an earlier model was used in this project) comes very close to fulfilling this need. However, a color display may be desirable.

Color Digital Photography

Pen-computers and color graphics are rapidly evolving technologies. Advances in these fields are continually making mobile computerized data collection more feasible and less expensive. Until the MPIU system is ready for widespread implementation, there should be a continuing program to ensure that the most advanced hardware which is available off-the-shelf is integrated into the system. For example, color digital photography is a rapidly maturing technology that could offer significant improvements over the monochrome digital photography used in the first-generation MPIU system.

Color would show more detail than black-and-white, especially during inspections in spaces such as ballast tanks or double bottoms where corrosion or deterioration of surface coatings are often indicated by the color of the surface. Color laptop and pen computers are available and their prices are quickly falling to reasonable levels, color digital cameras are also available.

5.3.3 Recommended Changes to the MPIU Software

Most of the suggested changes provided by inspectors after the technology demonstration are not recommended for inclusion at this time. The reasons for this are stated in the preceeding sections. Those changes that have the most merit are recommended below.

Marine safety database Interface

The responses of inspectors who participated in the MPIU pilot program indicate that until the MPIU system is integrated with the marine safety database, it will not have

significant beneficial effects on their efficiency. Therefore, integration of the MPIU and marine safety database systems should have first priority in future development. Since a new marine safety database is still years away, it is recommended that an interface with the current MSIS system be programmed

In general, it would be helpful if a single file containing all of the required vessel information could be extracted from the marine safety database with minimal inspector effort and loaded into the inspection computer. After the inspection, much of the work now done by inspectors at the terminal, such as writing the diary, generating deficiency codes, and updating due dates for the next inspection, would be done on the portable computer. A file of inspection results, ready for direct transmittal to the marine safety database would be created by the inspection computer. This filed could be either directly downloaded to marine safety database or could be reviewed administratively followed by direct download, with little or no data entry required at the marine safety database terminal.

Expanded Reference Database

The reference material included the current MPIU system is limited to those parts of Titles 33 and 46 of the Code of Federal Regulations which apply to inspection of tankships and tank barges. Any expansion in the scope of the computer inspection system to include other types of vessels will require, at the least, inclusion of more of Title 46.

In addition, the present configuration does not include a large body of reference material which is regularly used by inspectors. This material includes The Coast Guard Marine Safety Manual, particularly Vol. II, various Navigation and Vessel Inspection Circulars (NVICs), the steel vessel construction and repair rules of the American Bureau of Shipping (ABS), and a number of other references. Most of this information is now available in digital format and should be added to the references on the computer.

Context-Sensitive Access to Reference Materials

In order for computerized access to reference materials to be fully useful to inspectors, it must be integrated much more closely into the inspection programs, preferably as a context-sensitive reference function incorporated directly into the inspection programs. Several third-party add-on products for Visual Basic are now available which might help to implement access to a large reference database from within a Visual Basic program.

5.3.4 Training

The training session conducted for inspectors at MSO New Orleans included a one-hour overview, which was attended by about ten inspectors and other administrative personnel, and a four-hour detailed training session, attended by two inspectors. The mid-project inspector workshop and the final evaluation sessions indicated that neither the two inspectors who attended the detailed training session nor the other users, who were trained by

these two inspectors, were adequately trained in the use of the software or the hardware. Judging by their lack of familiarity with several important functions of the software, none of the users had apparently made much use of the MPIU system instruction manual.

It is clear that in the future, more time must be allocated to training if inspectors are to learn all of the capabilities of inspection programs, inspection computer hardware, and supporting software. The training session should include not only a classroom-type instruction session, but hands-on sessions in which inspectors actually use the software under the instructor's supervision, and some sort of evaluation procedure so that the instructor can ensure that the trainees have, in fact, become proficient with the system. Particular care must be taken that inspectors who will train other inspectors are properly prepared and are reasonably skilled in the use of the system.

6 REFERENCES

6.1 "Assessment of the Coast Guard Marine Safety, Security, and Environmental Protection (M) Program," NKF Engineering, Inc., Coast Guard Report No. CG-D-11-89, March 1990.

6.2 "On-Site Marine Inspection Data Capture," MAR, Inc., Coast Guard Report No. CG-D-05-93, December 1992.

6.3 G-MVI Policy Letter 25-93 dated 8 November 1993.

APPENDIX A MPIU USERS' MANUAL

(This appendix contains the complete MPIU Users' Manual, which was provided to MSO New Orleans at the beginning of the field trials there.)

The U.S Coast Guard Marine Portable Inspection Unit(MPIU) (prototype)

Tankship and Barge Programs

Users' Manual

by MAR, Inc.
for the U.S. Coast Guard R&D Center
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INTRODUCTION

BACKGROUND

The U.S. Coast Guard Marine Portable Inspection Unit (MPIU) has been developed to evaluate the use of portable computers in streamlining data management for U.S. Coast Guard Marine Inspectors. The system provides the means to record inspection findings electronically. Checkbox entries, text, sketches, and digital photographs are all available and are stored in a simple database format. In addition, a limited amount of reference material (important sections of the Code of Federal Regulations) is available, with computerized access tools.

The system is built around standard 80386 and 80486-based computers using MS-DOS and Microsoft Windows. Both custom-developed and commercially available software is used. The system is designed in such a way that the present software will remain compatible with improved hardware and operating systems which may become available in the future, and that future versions of the software will remain compatible with the existing hardware.

THIS MANUAL

This manual contains detailed descriptions and operating instructions for the computerized versions of the Tankship and Barge inspection books which are the heart of the MPIU system. The on-line Help facilities of the MPIU programs provide additional on-site guidance into the use of the programs.

Important aspects of the hardware and commercial software are also covered in this manual. Manufacturers' manuals are provided for all hardware and software vendor's manuals for all of the commercial software. MS-DOS, Windows, and all of the commercial Windows software included in the system also have on-line Help facilities.

OVERVIEW of the MPIU SOFTWARE

The MPIU system is built around two programs written specifically to implement the CG-840S Tankship Hull Inspection Book and the CG-840E Barge Inspection Book. These programs run under Microsoft Windows for Pen Computing, an enhanced version of Windows version 3.1. The MPIU software was developed with Microsoft Visual Basic version 3.0. The details of the MPIU software are described in a later section of this manual.

The examples in this manual are taken from the Tankship Inspection program. The operation of the Barge program is identical.

THE WINDOWS for PEN COMPUTING OPERATING ENVIRONMENT

Windows for Pen Computing (also called PenWindows) allows electronic pens to be used as input devices for specially equipped portable computers called pen-based computers or, simply, pen-computers. The pen assumes the functions of the mouse and of the keyboard. Mouse actions are executed by tapping the pen on the screen. A single tap and a double-tap are exactly analogous to single and double clicks of the left mouse-button.

Text entry is accomplished by printing directly on the screen. When printing on the screen with the pen, the track of the pen appears directly under the point of the pen, so the effect is exactly the same as writing on paper. The pen track is called "**Ink**". PenWindows converts ink into standard computer text by an electronic handwriting recognition process. Once the recognition takes place, the ink on the screen is replaced by normal text characters. The pen also functions as a freehand sketching device (and as an eraser, by depressing the barrel button), in which case the ink is retained in its native form as marks on the screen. A pressure sensitive switch in the tip of the pen acts as the left mouse button, allowing selection of text or objects and single and double-clicking.

PenWindows introduces a new concept for editing of text, called the "**Gesture**". There are twelve gestures (in addition to the standard Windows "select word" double-click or double-tap), which execute various editing commands. Some gestures act on selected text, others combine the selection and editing commands into a single pen stroke. Gestures are available for deleting letters, words, or groups of words, cutting selections to the Windows Clipboard, pasting from the Clipboard, and other actions. A quick-reference card provided with each pen-computer (and duplicated in Appendix C of this manual) shows and explains the gestures. The Windows for Pen Computing sections of the Compaq Concerto and Dauphin DTR-1 users' manuals describe the features and operation of Windows for Pens in detail. In

addition, the "Learning Pen Basics" program in the Microsoft Pen Tools group of the PenWindows Program Manager provides an interactive tutorial on the use of the pen as a text entry and editing tool.

Users are encouraged to experiment with pen text entry and gesture use. The Diary Form of the MPIU programs is a good place to do this. Feel free to open a dummy inspection file and use it for practice. An excellent and useful practice exercise would be to enter a previous inspection of a ship which is due to be reinspected. The existence of a previous computer inspection for any vessel makes the next inspection much easier, since much of the basic vessel information is automatically carried forward to the new inspection.

It is assumed that users of the MPIU system will be previously familiar with the basic operation of MS-DOS-based computers and with the basics of Microsoft Windows, including the use of a mouse for selecting objects and issuing commands, and the use of Windows Program Manager and File Manager. Basic word processing skills are also assumed. The simple word processing program built into Windows - Windows Write - is the word processing program provided with the System. Users are free to load and use any other Windows-based word processing program of their choice, subject to available disk space.

In addition to the custom-developed MPIU software, a number of supporting programs are included with the system:

ZYFIND

ZYFind is a Windows-based text searching program, which is used to provide access to the MPIU database, which consists of selected Subchapters of Titles 33 and 46 of the Code of Federal Regulations. Using keyword-based searches, ZYFind can provide access to the actual text of the CFR. ZYFind and the CFR database are available on the Compaq Concerto pen/laptop computer and the IBM laptop computer.

FOTOMAN and FOTOTOUCH

Fotoman is Logitech's Windows-based photo transfer utility program for the FotoMan digital cameras. This program accomplishes the downloading of stored photographs from the cameras, through their docking/charging stations to a computer. FotoTouch is a Windows-based image editing program which allows images from the cameras to be translated to other formats, edit, or enhanced. Both programs are installed on the IBM laptop and the Compaq pen/laptop computers.

FIELDNOTES

FieldNotes is included with the MPIU software primarily to demonstrate some of the capabilities of mobile computing; it is not a necessary part of the system. FieldNotes is a comprehensive Windows-based visual database program. The part of the program which will be of most immediate interest to inspectors is its ability to view and annotate engineering drawings. FieldNotes has many other functions, and it is undoubtedly the most sophisticated program yet developed specifically for use with pen-based computers. FieldNotes is available on the Compaq Concerto and on the IBM Thinkpad. Sample drawings of a naval vessel and of a wing tank of a crude carrier have been included for demonstration purposes. Any drawing which is available in the AutoCAD DXF file interchange format can be loaded, viewed, and annotated using FieldNotes.

THE COUNTERPOINT CD-ROM CFR

This program includes the entire text of 33 and 46 CFR (and many other Titles as well) on a single CD-ROM disk. It uses a simple hierarchical searching program to provide access to the material. The search program is executed directly from the CD-ROM, and takes no storage space in the host computer. The CD-ROM unit can be attached to any of the computers through the parallel printer port. The software is DOS-based and requires a keyboard. It is provided to demonstrate the potential of CD-ROM data retrieval and for comparison with the other method of access to this material provided by ZYFind.

OVERVIEW of the MPIU HARDWARE

The MPIU hardware consists of two sets of equipment based upon computers and including supporting equipment. The computers on which these two systems are based are different; the supporting equipment is identical for both systems. One system is based upon the combination of a Dauphin DTR-1, a very small and easily carried pen-based computer, and a standard laptop computer for desk work. The second system is based on the Compaq Concerto, a larger pen-based computer, which can also serve as a desk-based laptop. One of the purposes of the MPIU pilot project, in addition to evaluating the concept of computerized inspection data management, is to compare the two specific systems provided.

The two pen-based computers and the laptop can operate on batteries or on AC power. Spare batteries and separate charging units are provided for the pen-computers. In addition to the pen-based and laptop computers and their power supplies, battery chargers, and spare batteries, each system includes the following supporting hardware:

Portable CD-ROM reader (Microsolutions BackPack)
Portable ink-jet printer (HP DeskJet 310)
Black-and-white digital camera (Logitech FotoMan)

The two pen-based computers, with or without the laptop, can serve as the basis for an inspection system which allows two inspectors to operate independently on the same inspection. Merging capabilities are provided in the software.

THE DAUPHIN - IBM SYSTEM

The first system, built around the Dauphin, offers a lightweight, easily carried, small mobile computer, at the expense of a fairly small screen display. Because of the smaller size, undersize keyboard, and memory capacity of the Dauphin, the standard laptop is required to support it, so more pieces of equipment must be carried to the ship.

THE COMPAQ CONCERTO SYSTEM

The second system, built around the Compaq, offers a large display at the expense of greater weight and size. However, the Compaq has a larger hard disk and a standard-sized keyboard, eliminating the need for a supporting laptop computer and cutting down on the total amount of equipment which must be carried.

PRINTERS

Two HP DeskJet 310 portable inkjet printers are provided. These can be used with any of the three computers and connect with a standard parallel printer cable. Two cables are supplied, one for each system.

The printers operate from separate AC power supplies. They can be used with or without optional sheet feeders (which are provided). For mobile use where only a few pages are likely to be printed, considerable weight and bulk can be saved by leaving the sheet feeders back at the office.

DIGITAL CAMERAS

Two Logitech FotoMan digital cameras are provided. Each has a docking/charging unit. The black FotoMan II is a later version and has slightly better resolution than the white FotoMan I; otherwise, operation of the two cameras is identical.

The cameras do not need to be connected to any supporting hardware when taking pictures. Each camera can store 32 images before they must be downloaded and the batteries recharged. Depending upon flash usage, it may be possible to take more than one full load of pictures (32) before recharging is required. Charging takes about an hour. Downloading 32 images takes only a minute or two.

CD-ROM DRIVES

Two MicroSolutions portable CD-ROM readers are provided. These CD-ROM drives use a parallel interface and draw power from an external AC adapter. The support software is provided in the Compaq pen/laptop and the IBM laptop. When the CD-ROM drives are in use, they are connected directly to the computer's parallel port. If a printer is used simultaneously, it is connected to the printer port on the back of the CD-ROM drive.

POWER MANAGEMENT

Power management techniques are important for extending the useful battery lifetime of portable computers. Both the Compaq and the Dauphin have sophisticated power management schemes.

The Dauphin DTR-1, the Compaq Concerto, and the IBM Thinkpad use replaceable Nickel-Metal Hydride (NiMH) battery packs. NiMH batteries have negligible "memory" effects, so there is no need to discharge a battery fully before charging it; a partially discharged battery can be "topped off". There is no danger in leaving a battery charging either in the computer or in a charging unit beyond the time

required for full charging. The length of battery life for all three computers is highly dependent on the amount of screen backlighting used.

IBM ThinkPad 300

The IBM Thinkpad laptop is provided with one battery pack and with one AC adapter which can operate the computer and charge the battery simultaneously, although charging is somewhat faster with the computer turned off. This computer, however, is likely to be used mostly where AC power is available.

Dauphin DTR-1

The Dauphin DTR-1 is provided with one extra battery pack. There is also an external battery charging unit. The two AC power supplies are interchangeable between the computer and the charging unit.

The Dauphin will operate for 2-3 hours of normal use on one charge. When plugged in to the power supply, either in use or in suspend mode, the battery will hold its charge level but will not charge up. The computer must be fully turned off using the side slide switch in order for the battery to charge while in the computer. The charging time for a fully discharged battery is about 2 hours, either in the computer (with the computer turned off) or in the charging unit.

The Dauphin's battery can be "hot swapped" with the machine in suspend mode. In this mode, program execution is frozen and the screen is darkened, but execution can be resumed where it stopped once the change is made and the machine is awakened from suspend mode. There is no need to exit a running application to make a battery swap and no data is lost. However, if the battery is removed with the machine in active mode, all data will be lost and the machine will reboot when the new battery is inserted.

Compaq Concerto

The Compaq Concerto is provided with one spare battery pack, one charging unit, and with one AC power supply which can power either the computer or the charging unit. The charging unit can accommodate two batteries.

The Compaq will operate for 2-4 hours of normal use on one charge. The battery in the computer will charge up either while the computer is operating or in "standby mode" (somewhat faster with the machine in standby mode). The Compaq's battery can also be "hot-swapped" when the computer is in standby mode. It is suggested that all files be saved before a hot-swap is done on either of the pen-computers. Be very careful not to mistake the Windows "screen-saver" mode for standby mode.

If an attempt to hotswap the batteries is made with a computer in screen-saver mode, it will reboot and data will be lost.

The Compaq has several power-saving modes: "screen save", "standby", and "hibernation". In screen save mode, the hard drive stops and the screen is turned off. This state initiates automatically after several minutes of inactivity. The system is revived with a pen tap on the screen. In standby, the screen, hard disk, and processor stop, but the system can be revived by pushing down the standby button next to the screen. Standby initiates automatically after 5 minutes in screen save mode. In hibernation, the computer saves its state to the hard disk and shuts off completely. Hibernation initiates automatically after 30 minutes in standby mode. The system is revived by pressing the standby switch, which results in a special boot sequence which returns the system to the exact state it was in before hibernation.

Using Multiple Batteries

When using either the Dauphin or the Compaq for an inspection, the best strategy is to bring along two fully charged batteries, along with an AC adapter and the charging unit. Once one battery is exhausted, it can be put on charge in a protected location. Since the charging time of a battery in the charging unit is considerably shorter than the usable battery lifetime (this applies to both machines), two battery packs should provide for indefinite continuous mobile use as long as power is available for the charging units.

PEN COMPUTERS AND MS-DOS

The pen-computers are both configured to load Windows immediately upon booting up. Since the pens will not function as text entry or pointing devices under MS-DOS, pen computers which do not have their keyboards attached cannot run MS-DOS programs either inside or outside the Windows environment (a few DOS programs can use the pen as a mouse with special drivers). The MS-DOS prompt is not available from Windows without a keyboard. If Windows is exited, the computer becomes unusable, and must either be rebooted or connected to its keyboard. MS-DOS commands and MS-DOS on-line help are not accessible to a pen-computer without its keyboard.

THE MPIU SOFTWARE

INTRODUCTION

The principal elements of the MPIU software are the computerized versions of the Tank Vessel Hull Inspection Book (CG-840S) and of the Barge Inspection Book (CG-840E). The organization of the programs loosely follows that of the paper books, with some modifications to take advantage of the computer interface.

The MPIU programs are fully functional Microsoft Windows programs, which make available all of the facilities of the Windows interface and have the common appearance and functions of familiar Windows programs, plus the added capabilities of Windows for Pen Computing. Among these features are:

1 Concurrent Execution - The MPIU programs can be run simultaneously with other applications, such as ZYFind, the database-searching program provided with the MPIU system, or a word-processing program such as Windows Write. Multiple instances of the MPIU program can even run concurrently.

2 Clipboard Support - Text comments can be copied from the MPIU program to other programs using the Windows Clipboard.

3 Help File - Both the Tankship and Barge Inspection Programs have standard Windows Help. After selecting Help, users can tap a topic in the Help Contents screen and jump directly to an explanation of that topic. Tapping any highlighted term in a Help screen will jump directly to another Help screen explaining that topic.

4 The Pen - The Pen assumes most of the functions of a keyboard and a mouse, including: menu picking and button clicks; text entry, selection, and editing; freehand drawing; and combined object selection and command entry using the Windows for Pen Computing pen "gestures". When a keyboard is attached to a pen computer, the pen and the keyboard function concurrently; the pen takes the place of a mouse, and both the keyboard and the pen can be used to enter text.

Flexibility

The number of individual vessel inspections which can be in progress at one time is limited only by the available hard disk space of the computer on which the software is running. An inspection of a given vessel can be stretched over a period of time by the same or different inspectors, with all data saved between sessions.

Elimination Of Duplication Of Effort

Certain data fields (for example, the vessel's name and registry information, hull information, certificate dates, hydrostatic test dates, and many others) have been tagged as semi-permanent, and are retained (but can be edited) when a new inspection is started for a vessel which was previously inspected. (Checkbox entries are not made for any data copied to a new inspection - such determinations are completely up to the inspector). This information can be transferred electronically from one computer to another, and eventually from one inspection office to another.

Inspection data files for completed inspections, or for inspections in progress, can be transferred from one computer to another easily, so an inspection can be continued with another machine.

CHANGES FROM THE PAPER INSPECTION BOOKS

The principal organizational change to the Tankship book has been to combine the material in Parts I (U.S. Tank Vessels), Part III (Foreign Tank Vessels), and Part IV (Vessels Carrying Hazardous Liquids) to eliminate duplications between these Parts. the combined material has been reorganized into Inspection Topics, such as Safety, Firefighting, Cargo, Etc. The program reconfigures automatically when a vessel's country of registry is entered. Entries are automatically activated or deactivated, depending upon the vessel's registry.

It is assumed that tank vessels are subject to Part IV (Vessels Carrying Hazardous Liquids). In the case of a tank vessel not carrying hazardous materials, Inspection Items which do not apply can be left blank, or checked "NA".

Only minor changes have been made in the organization of the Barge inspection book during the transition to electronic form. Despite the reorganization of the books, every individual bulleted item in both books has been retained. In the tankship book, some of these bulleted items now apply to both U.S. and foreign vessels.

THE ORGANIZATION OF MATERIAL IN THE MPIU PROGRAM

The material in the electronic inspection books is divided into nine Inspection Topics such as Safety, Fire, Navigation, etc. These Inspection Topics roughly correspond to the lettered sections of the inspection book (Lifesaving Equipment, Fire Protection Equipment, Navigation Equipment, etc.). Each of the Inspection Topics heads up a 3-level organizational structure. Each of these levels has a characteristic screen display, referred to as a "Form".

The First-Level Forms of each inspection program (Form types are explained below) present the organization of the program. These Forms are reproduced for the Tankship program in Appendix A, and for the Barge program in Appendix B. The Tables of Contents of both programs show the original organization of the inspection books. Figure 1 shows the overall logical layout of the programs, which applies to both the Tankship and Barge programs.

APPENDIX A

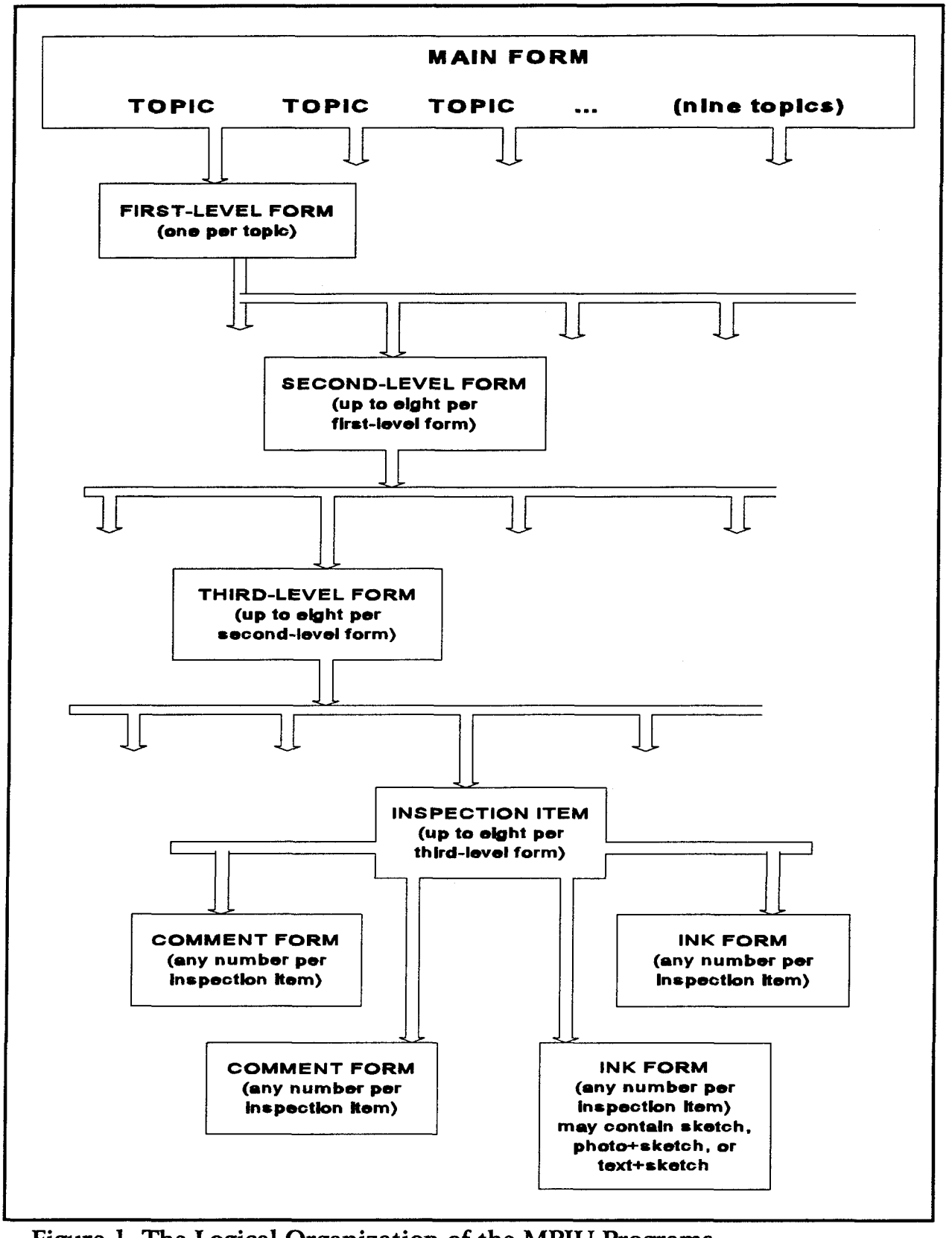

Figure 1 The Logical Organization of the MPIU Programs

The Opening Screen

The Opening Screen introduces the program, and is only seen before any inspection files are loaded. This screen prompts for entry of the inspector's name, which must be entered before continuing to the next screen. Figure 2 shows the Opening Screen.

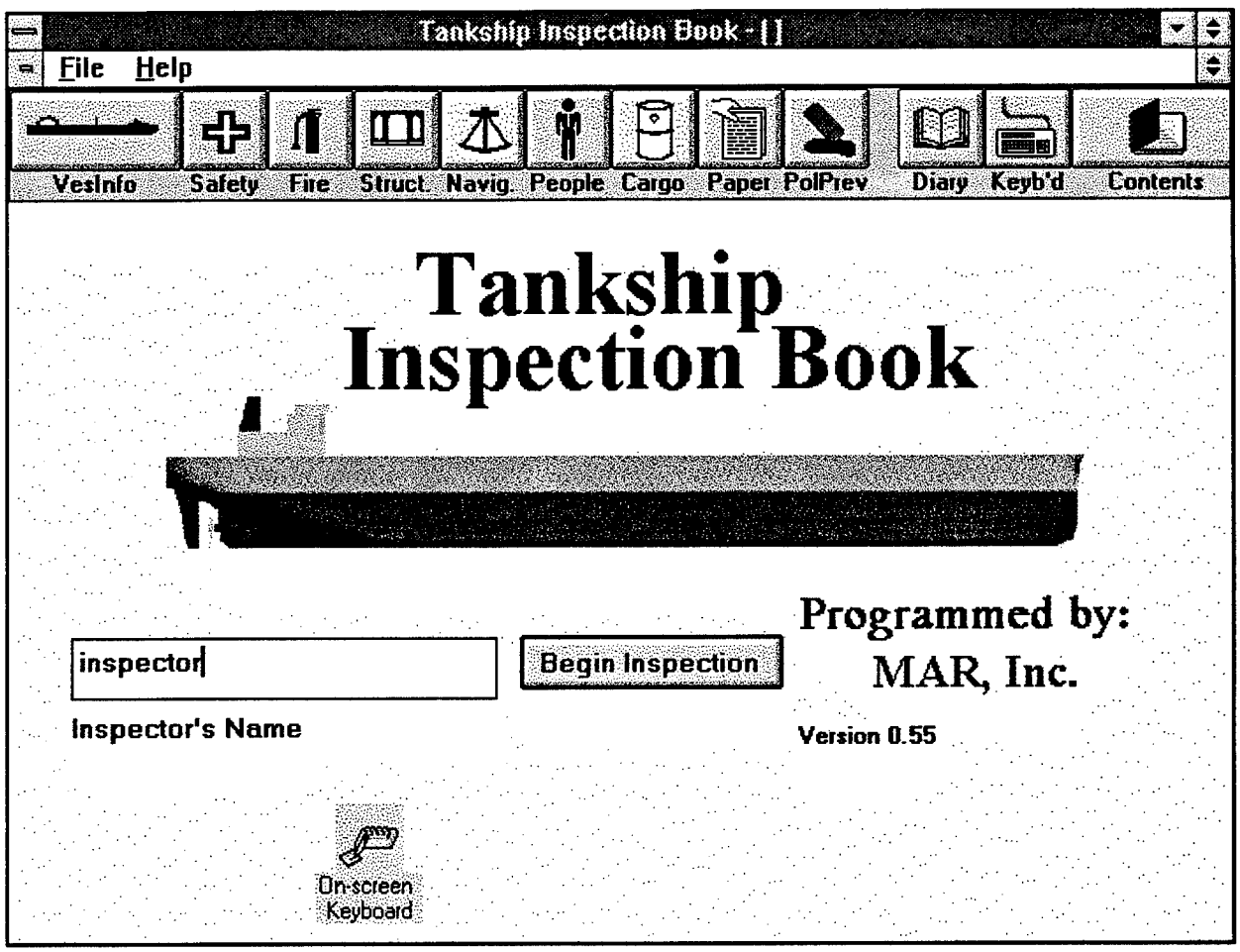

Figure 2 The Opening Screen of the Tankship Program

The Main Form

The Main Form fills the entire screen after the Opening Screen is exited, forming a background for other forms. The upper part of the Main Form occupies approximately the top 20% of the screen. The Main Form consists of (top to bottom) The Title Bar, The Main Menu, and a row of labelled Icons. Figure 3 shows the Main Form.

First-Level and Second-Level Forms (which are discussed below) occupy the lower part of the Main Form. When a First-Level of Second-Level Form is displayed, all commands on that form and all commands in the upper area of the Main Form are simultaneously functional. Third-Level Forms, Comment Forms, and Ink Forms (also discussed below) partially obscure and deactivate the upper part of the Main Form.

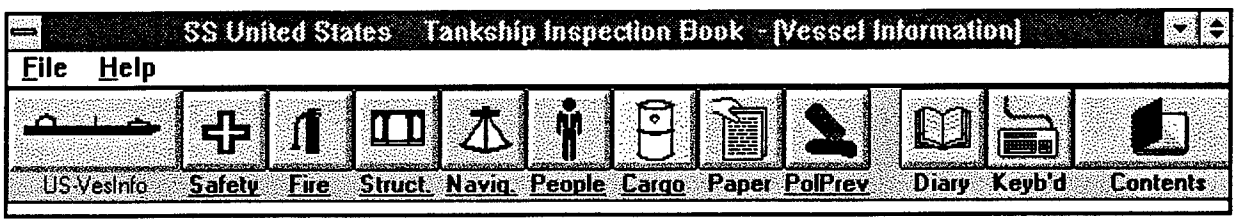

Figure 3 The Upper Part of the Main Form of the Tankship Program

The principal elements of the Main form are:

1 The Title Bar, which shows the vessel's name, the name of the inspection program (Tankship or Barge) and, in square brackets, the name of the current Inspection Topic and subtopic (the active First-Level or Second-Level Form - explained below). As with all Windows programs, at the left of the Title Bar is the program control menu box, which allows the user to minimize the program to an icon, close it, or switch to another concurrently running application (such as a word-processing or text-searching program). At the right of the Title Bar are the Minimize and Resize Boxes, the functions of which are standard in all Windows Applications. It is unlikely that there will be any occasion to resize the screen.

2 The Main Menu includes the File and Help pull-down menu commands. The File menu allows new inspections to be initiated for new or previously inspected vessels, allows inspections-in-progress to be continued where they last left off, and also allows printer setup, report setup and printing, and program termination. The Help pull-down leads to the MPIU Help File and the "About" program screen.

3 The leftmost 9 Icons activate the Inspection Topics (Vessel Info, Safety, Fire, etc.). The three icons to the right activate the Inspection Diary scratchpad, the on-screen keyboard, and the Table of Contents. Each Inspection Topic roughly corresponds to the lettered sections of the paper inspection book. The lettered sections from various parts of the inspection book (U.S., Foreign, Pollution, Hazardous Liquids) have been combined.

First-Level Forms

Each Inspection Topic leads to a single First-Level Form, in which the material for that Topic is divided visually into as many as eight sub-topic columns, each of which contains up to eight specific inspection categories. These inspection categories correspond to the numbered checkbox items in the paper inspection book. Status information for each subtopic (Complete, Incomplete, Deficiencies, Incomplete and Deficiencies) and a list of the inspection categories contained in each subtopic is displayed on the First-Level Form.

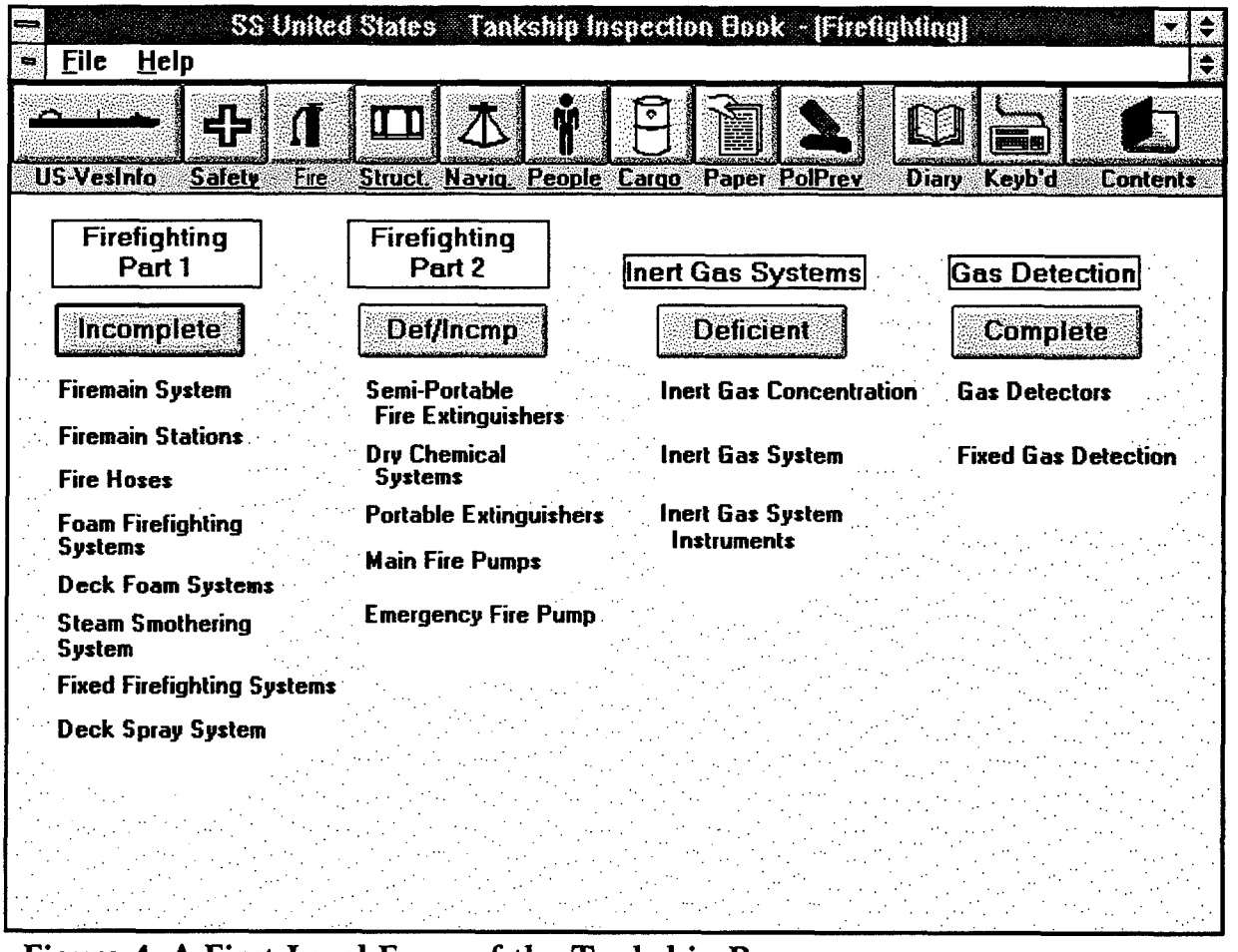

Figure 4 A First-Level Form of the Tankship Program.

The Menu and Icons of the Main Form, including the Table of Contents, are visible and accessible from any First-Level Form. Thus, you can switch directly to another Inspection Topic or use the Table of Contents (TOC) at any time from a First-Level Form. Figure 4 shows a typical First-Level Form. The Active Inspection Topic ("Fire", in this case) is denoted by the "pushed-in" button (which is not easily visible in the reproduction of the screen). In addition the the button, the icon label text is changed for the Active Topic. The illustrations in this manual show the label of the Active Topic in regular text and the other labels boldfaced. In the latest revision of the program, this has been changed to be more consistent with status indicators on other forms; the Active Topic label is now boldfaced, and the other labels are displayed as regular text.

Second-Level Forms

Each of the sub-topics on a First-Level Form (there can be as many as eight) leads to a single Second-Level Form, which shows the inspection categories for that subtopic, along with status information for each category.

The Menu and Icons of the Main Form, including the Table of Contents, are visible and accessible from any Second-Level Form. As with a First-Level Form, you can Switch Topics or use the TOC directly from any Second-Level Form. Figure 5 shows a typical Second-Level Form. Again, the Active Topic on the Main Form is denoted by the regular text of its label, while the other labels are boldfaced.

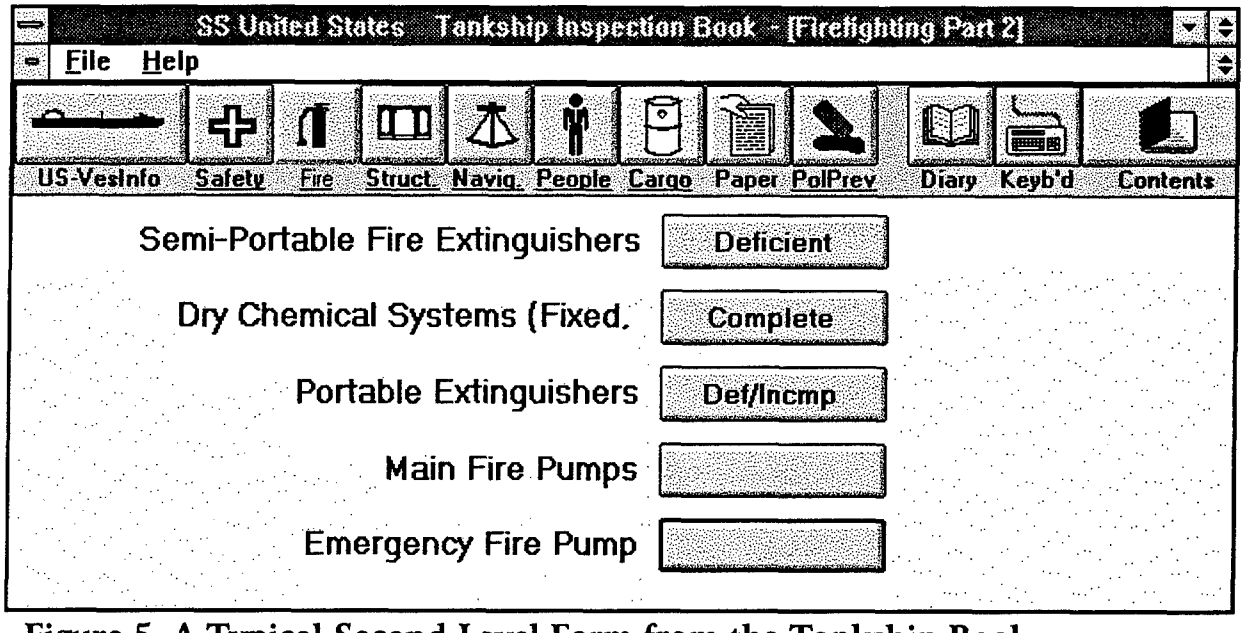

Figure 5 A Typical Second-Level Form from the Tankship Book

Special Second-Level Forms

There are several special Second-Level Forms in Tankship program and many in the Barge program. These forms have direct data entry areas, a function normally reserved for Third-Level Forms. The Forms under the Vessel Information topic for both programs are all special Second-Level Forms, as are several others. Some special Second-Level Forms have Third-Level Forms associated with them for additional data entry, some do not. Figure 6 shows an example of a special Second-Level Form, which, in addition to direct data entry areas, has two Third-Level Forms under it. Figures 7 and 8 show special Second-Level Forms associated with the Vessel Information Topic of the Tankship program.

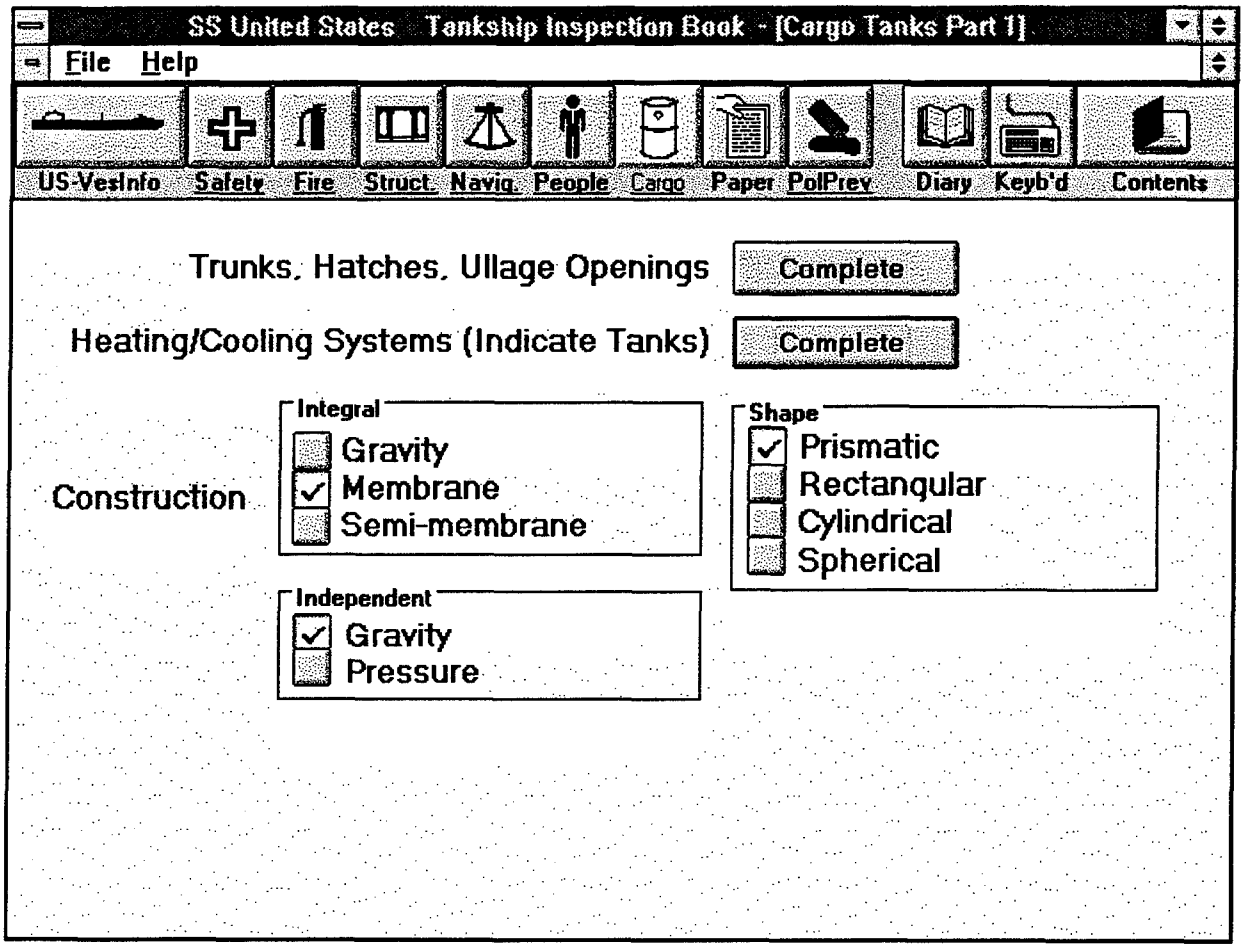

Figure 6 A Special Second-Level Form from the Tankship Program

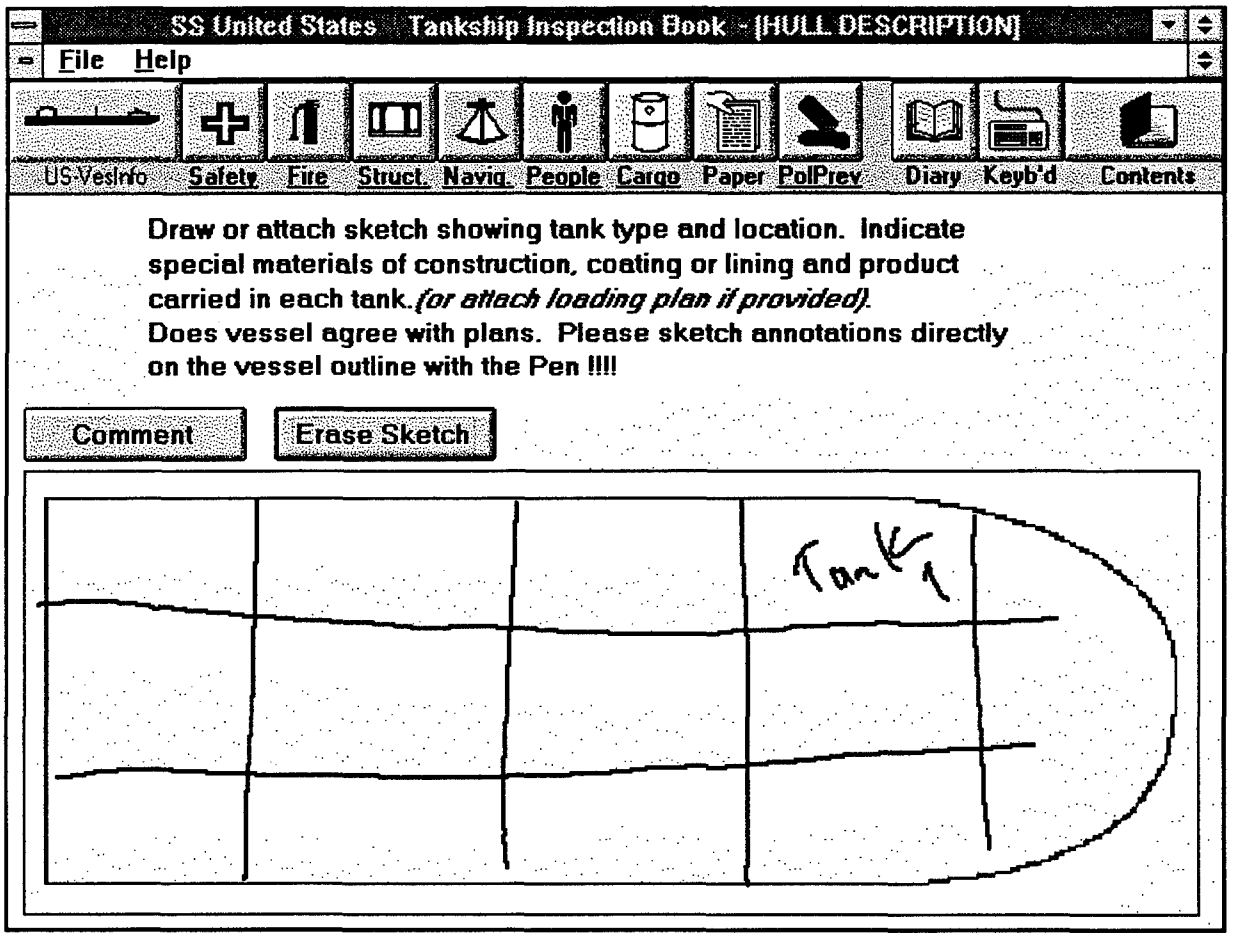

Figure 7 The Tankship Hull Description Second-Level Form

Figure 7 shows one of the special Second-Level Forms under the Tankship Vessel Information Topic. This form is an exact copy of the corresponding page of the Tankship Inspection Book, and allows ink entry.

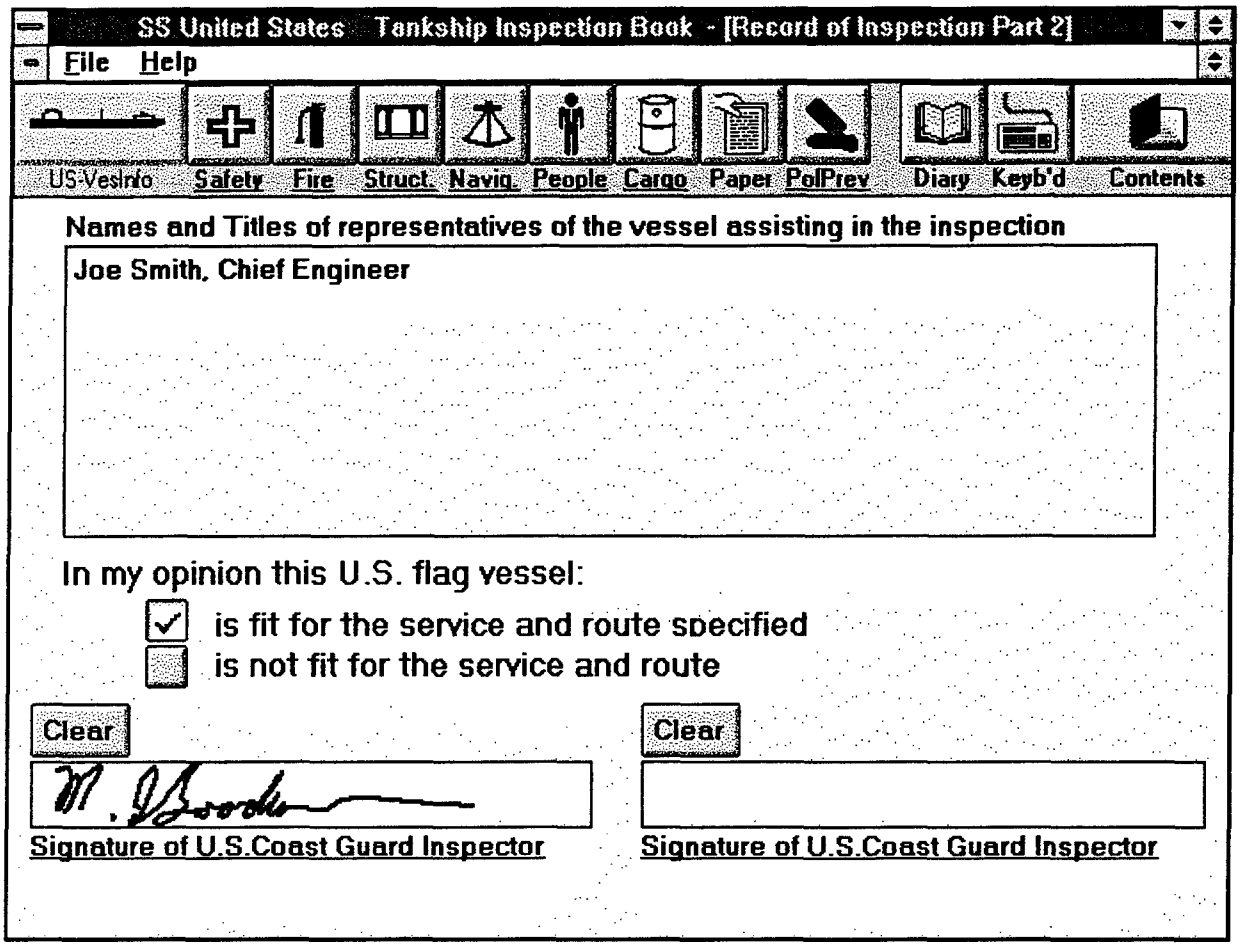

Figure 8 The "Record of Inspection Part 2" Form from the Tankship Program

Figure 8 shows another special Second-Level for from the Vessel Information Topic of the Tankship program. It includes a Text Box and two ink-only signature boxes.

Third-Level Forms

Each of the categories on a Second-Level Form leads to a single Third-Level Form, which is where most of the individual inspection entries are made. Each Third-Level Form includes up to eight Inspection Items. Each individual item corresponds to a round-bulleted item in the paper inspection book. Multiple-choice buttons (SAT, UNSAT, and N/A) are provided for all Inspection Items, and some items have text entry boxes or date entry boxes, also. Figures 9 and 10 show typical Third-Level Forms.

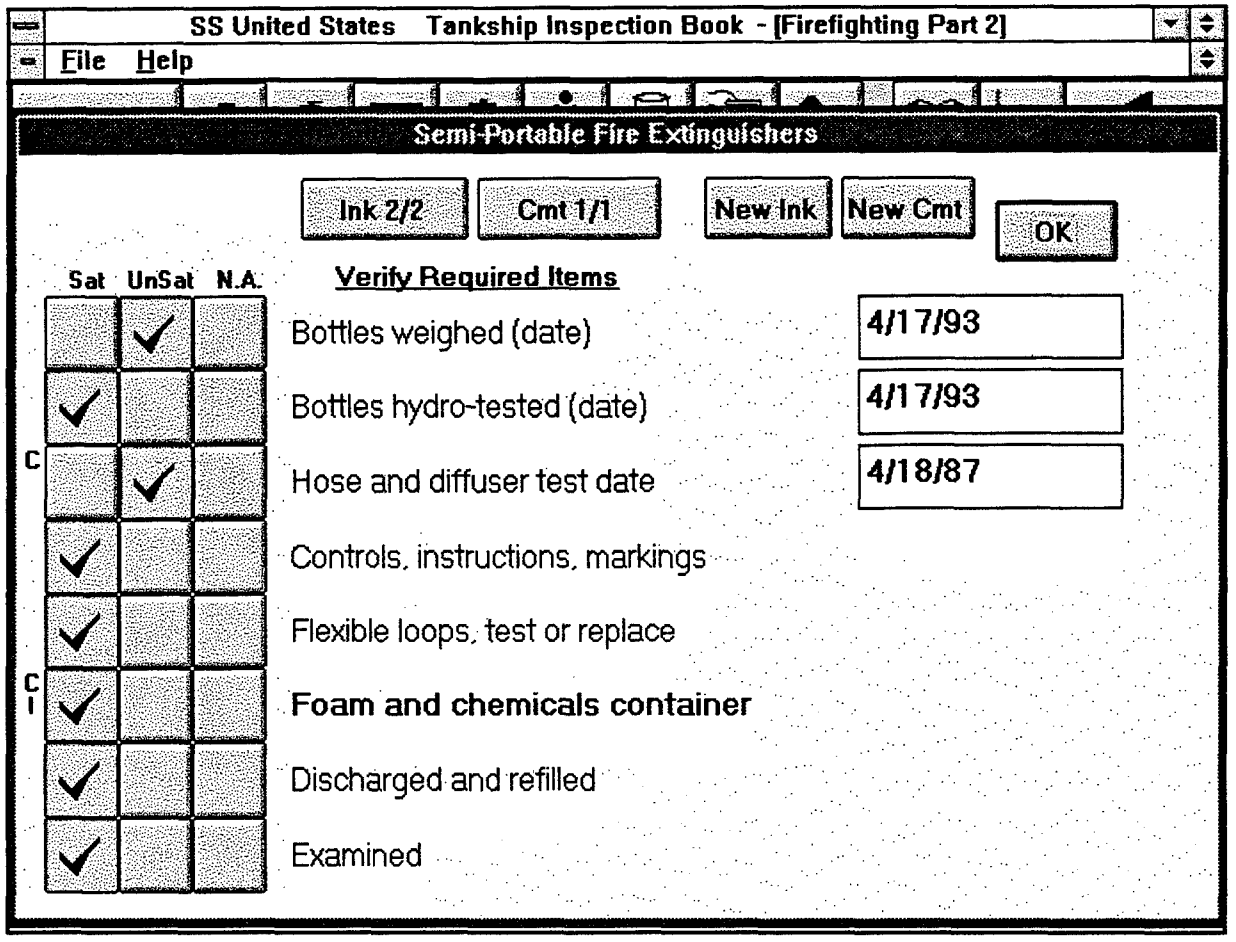

Figure 9 A Typical Third-Level Form with Date Entry Boxes.

The Third-Level Form shown in Figure 9 exhibits all of the controls and status indicators which are possible on a Third-Level Form. The Active Item (Foam and chemicals container) is boldfaced, and the Ink and Comment control buttons at the top of the form therefore apply to that item. The "**Ink 2/2**" indicates that two Ink Forms are linked to this item, and that Ink #2 was the last one opened, and will be the first one opened if the button is clicked (the other existing Ink Form is accessible from the first one opened). The "**Cmt 1/1**" indicates that there is one comment linked to the item. The "**New Ink**" and "**New Cmt**" buttons can be used to create new Inks or Comments for the active item.

The item "Hose and diffuser test date" also has Ink (but no Comments) linked to it, as indicated by the Ink and Comment indicators to the left of the checkboxes. These indicators show the existence of Inks and/or Comments for all items on the Third-Level Form, but do not show how many there are. The more detailed Ink

and Comment buttons at the top of the form apply only to the active, boldfaced item.

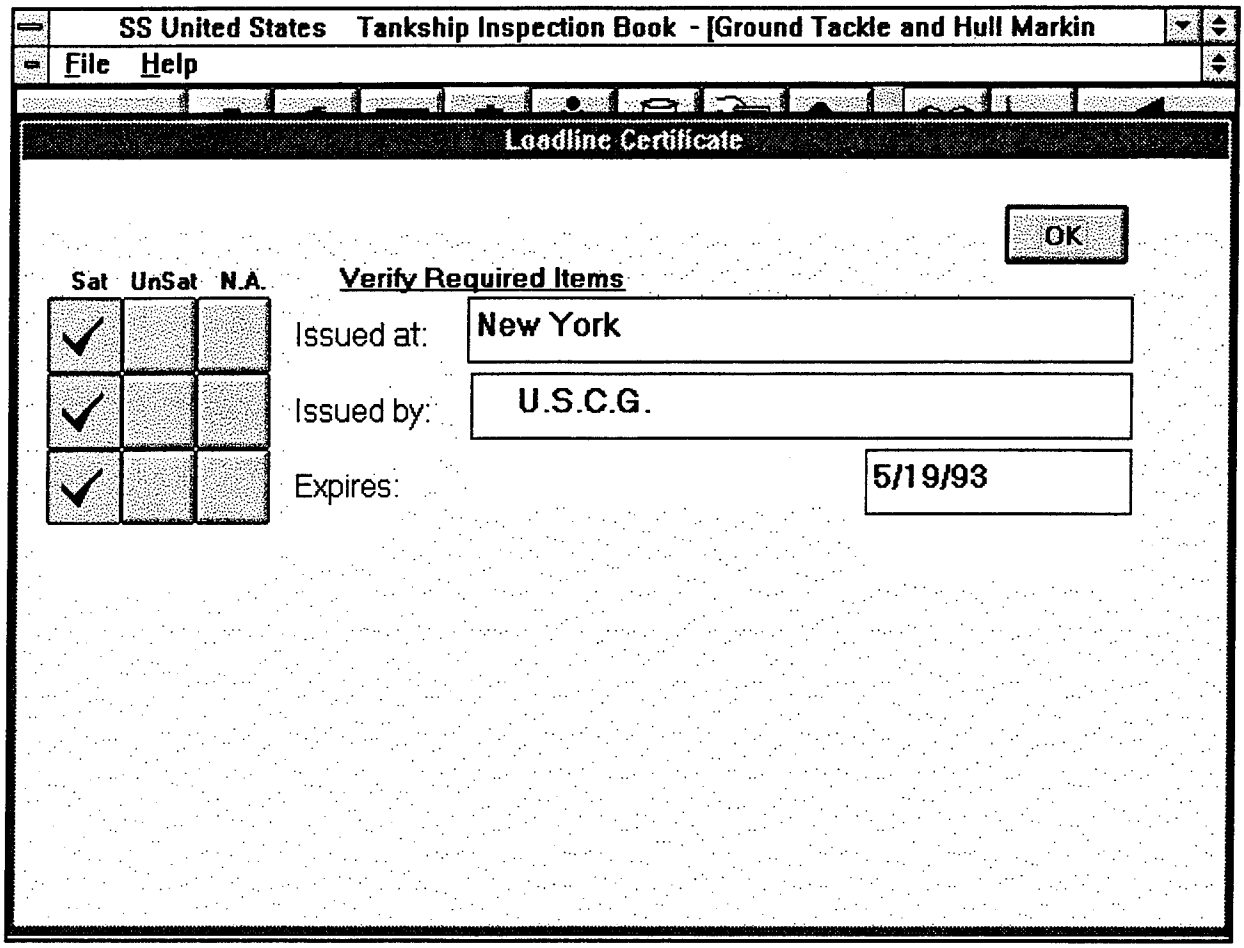

Figure 10 A Third-Level Form with Text and Date Boxes

The Third-Level Form shown in Figure 10 has text and date boxes, which are filled in with the help of the Text Entry Form and the Date Edit Form. The Text entry Form is accessible by making the edit gesture in the box (a large checkmark). The Date Edit Form is accessible by merely tapping the pen in a Date Box.

The Main Form is partially obscured by and is not accessible from Third-Level Forms; you must exit a Third-Level Form in order to use the Table of Contents or to switch to another Inspection Topic. This limitation is necessary to ensure that the status indicators are properly updated when the information on a Third-Level Form is altered.

Comment and Ink Forms

Multiple text comments or sketches (referred to as "Inks") can be recorded for each individual inspection item on a Third-Level Form; these comments and sketches remain linked to that particular item. Ink forms can import digital photographs and these can be annotated by sketching. All comments and sketches can be reopened as many times as necessary for editing.

The Main Form is completely obscured by and is not accessible from Comment and Ink Forms. In order to switch Inspection Topics or use the Table of Contents from a Comment or Ink, you must exit the Comment or Ink, then exit the associated Third-Level Form.

Comment Forms

Three types of Comments are available: Open, Cleared, and General. The types are toggled by the Type Box at the top of the Comment Form. Open comments have the same status as an "UNSAT" checkbox for any inspection item. A comment form is placed in the Cleared state when an unsatisfactory condition is corrected during the course of an inspection. Cleared comments are displayed with crossed-out text, and are treated as a special type when hard-copy reporting options are selected. Comments which are not entered as a result of an unsatisfactory condition should be assigned the General type. The three types of comments are treated differently when reporting options are chosen. Figure 11 shows a comment form.

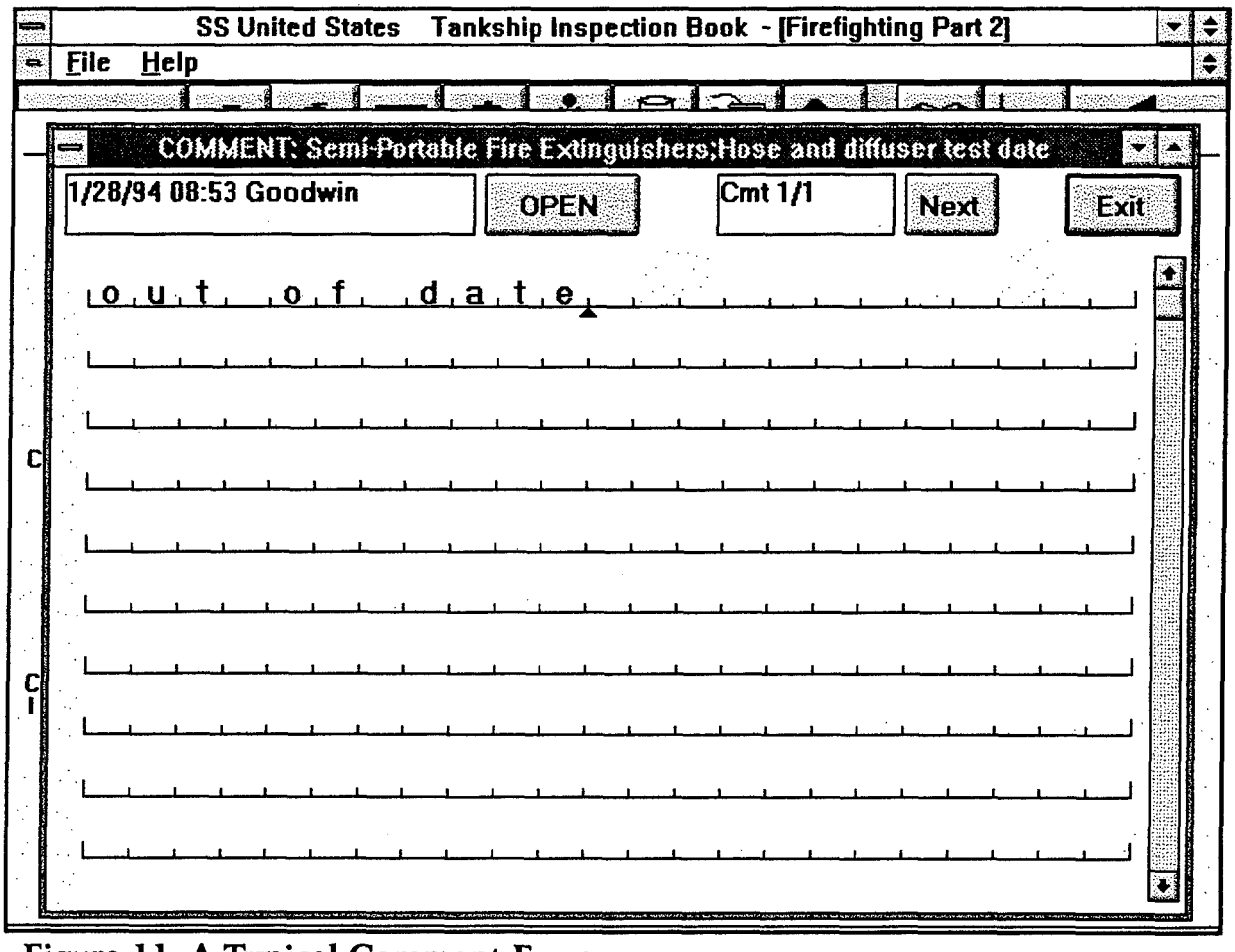

Figure 11 A Typical Comment Form

Ink Forms

Ink Forms are analogous to Comment Forms, in that as many as required can be linked to a single inspection item at the Third Level. Ink forms store freehand sketches made with the pen; there is no recognition of printed characters in an ink form. Figure 12 shows an Ink Form with a freehand sketch.

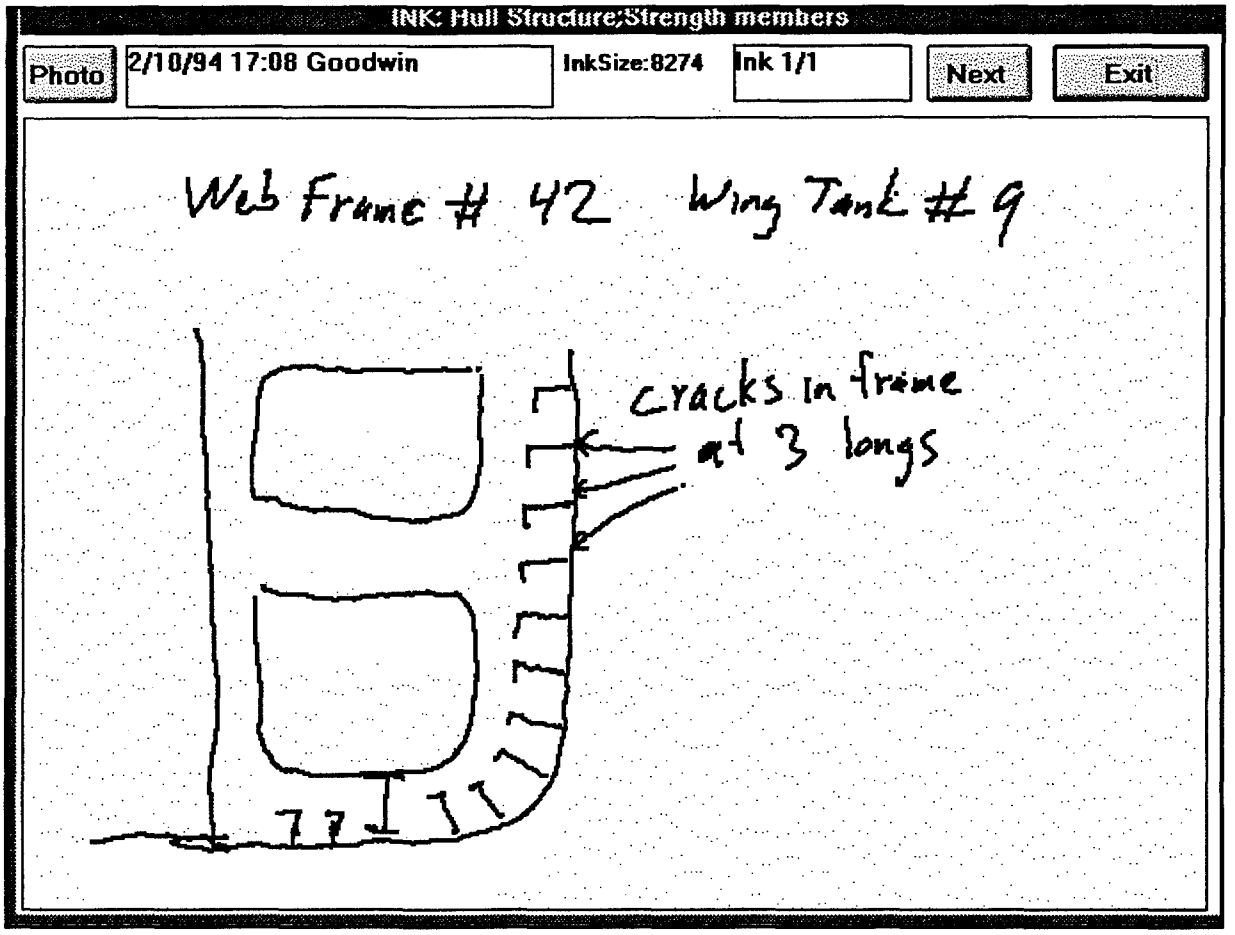

Figure 12 An Ink Form with a Freehand Pen Sketch

Importing Photos into Ink Forms

Ink forms can also import photographs and text files. Photos must have been previously downloaded from the digital camera into the inspection directory being used by the program, in bitmap (.BMP) format. Tapping the Photo button brings up a list of available photos. Selecting the photo filename loads the photo into the Ink Form. Tapping Photo again, and selecting another photo filename replaces the existing photo with the new one, or none.

The **Photo** button can also import an image of a text file into an ink form. Any text file located in the inspection directory can be imported. Only the first 25 lines or so of the file will show, and the imported text can not be edited or manipulated in any way. However, it can be annotated with ink in the same way that an imported photo image can be annotated. This capability might be used, for example, to import a short quotation from the CFR directly into the inspection file. This is not the general method for printing citations from regulatory materials,

however. (This is most easily done from ZYFind by selecting the desired citation and either printing directly or copying to the Windows Clipboard and pasting into a word-processing program such as Windows Write.

Sketches and textual annotations (which are not "recognized" into computer text) can be superimposed on the photo or placed outside its borders. Pressing the barrel button of the pen turns the pen into an eraser, which erases the ink but does not affect the underlying photo. Ink forms are stamped automatically with the date and time of creation, as well as the name of the inspector who began the session. If a photo are linked to an Ink Form, the filename of the photo is also displayed. Figure 13 shows an Ink form with a photo, annotated with Ink.

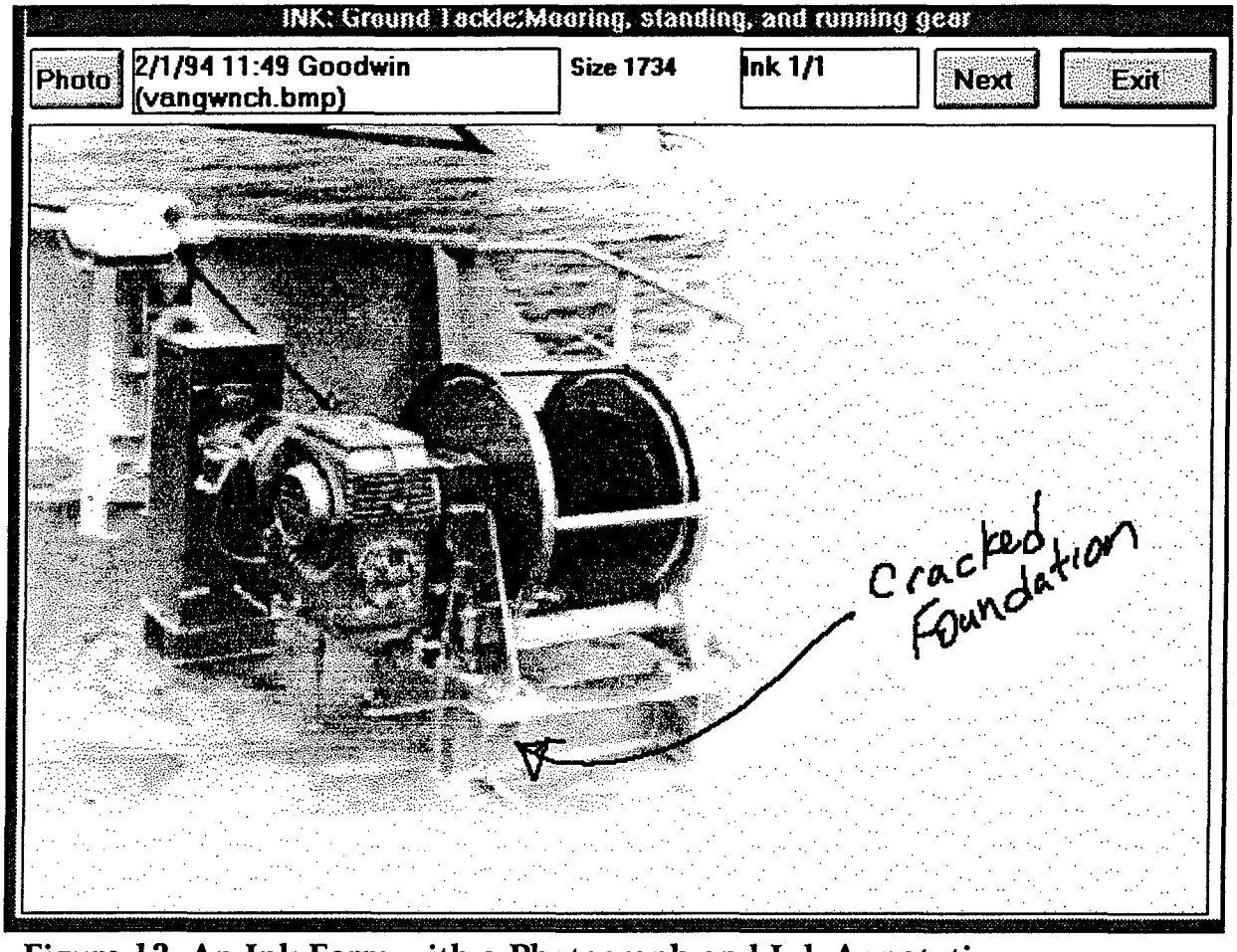

Figure 13 An Ink Form with a Photograph and Ink Annotation

THE EFFECTS OF VESSEL REGISTRY

For tankships, certain items which apply to only U.S. or only Foreign vessels are deactivated when they do not apply. The Vessel Flag, which is entered in the

"Hull Information, Part 1" Form of the Vessel Info Topic, determines how the program displays flag-state sensitive items. The labels of deactivated items are grayed-out, but still barely visible. Checkboxes associated with deactivated items do not respond to tapping. However, Comments and Inks can still be entered for deactivated items. The Barge Inspection program is not sensitive to a barge's registry.

Figure 15, a few pages below, shows the "Hull Information Part 1" Second-Level Form of the Tankship program; the basic vessel information is entered on this form. When a new inspection is begun for a Tank vessel or a barge not already on file, this form appears immediately after the **Open Ship/Inspection** screen, with a prompt to enter the vessel's name and (for the Tankship book only) its registry. These entries must be made before continuing with the inspection.

For example, in the Tankship program, for **Safety - Lifesaving Equipment**, there are six items on a Third-Level Form for U.S. Vessels, but only a single **"SAT/UNSAT"** checkbox on the Second-Level Form for Foreign Vessels. The Third-Level Form still exists for foreign vessels, but its checkboxes are deactivated and the labels are "grayed-out". However, since comments are expected for all **"UNSAT"** entries, and since comments (or Inks) can only be attached to Third-Level Forms, comments (or Inks) can still be entered for any Inspection Item on the Third-Level Form under the Second-Level Form, even when the checkboxes are deactivated because of the vessel's registry. This allows for detailed identification of the reason for an **UNSAT** check, and makes deficiency reports more specific.

An Open Comment attached to a deactivated Item on a Third-Level Form will still be reported on a hardcopy open-deficiency report, identified by the name of the Third-Level Form and the name of the Item, and with an indicator showing the existence of an Open comment, even when the Item, or the entire Third-Level Form, is deactivated for that particular inspection.

NAVIGATING THROUGH THE FORMS OF THE MPIU PROGRAM

Data can be entered into the program in any order desired, once the initial setup has been accomplished. The user has total control over the information recorded - any data can be edited or deleted at any time.

Starting an Inspection

To start an inspection, the inspector's name is required on the Opening Screen. The user then begins an inspection, for which there are then three options, all accessible through the File option of the Main Menu. The three options are:

1 Continue an Inspection in Progress

(File - Open Ship/Inspection - *select existing ship/date*)

This option reloads a partially completed inspection data file.

2 New Inspection of a Ship on File

(File - New Ship/Inspection - *select existing ship/date*)

This option loads the basic vessel information and certain inspection data items which are not likely to change from one inspection to the next. It would normally be used to begin a reinspection of a ship which had been previously inspected. It can also be used to create a small basic inspection data file from the full record of a previous inspection - this might be done to facilitate a reinspection of a ship previously inspected in a different inspection zone.

3 New Inspection of New Ship

(File - New Ship/Inspection - OK)

You will be immediately prompted to enter the vessel's name and registry. The system date will be used as the date of creation of the inspection.

This option begins a new inspection from scratch - all of the basic vessel information must be entered. A New Ship inspection is begun in the case of an initial inspection for certification or for a ship which has not yet had a computerized inspection performed. This basic information might be entered into the file at the office from the MIPIP and other sources before the inspection. It can be edited later on board if necessary. Figure 14 shows the Open Inspection Screen.

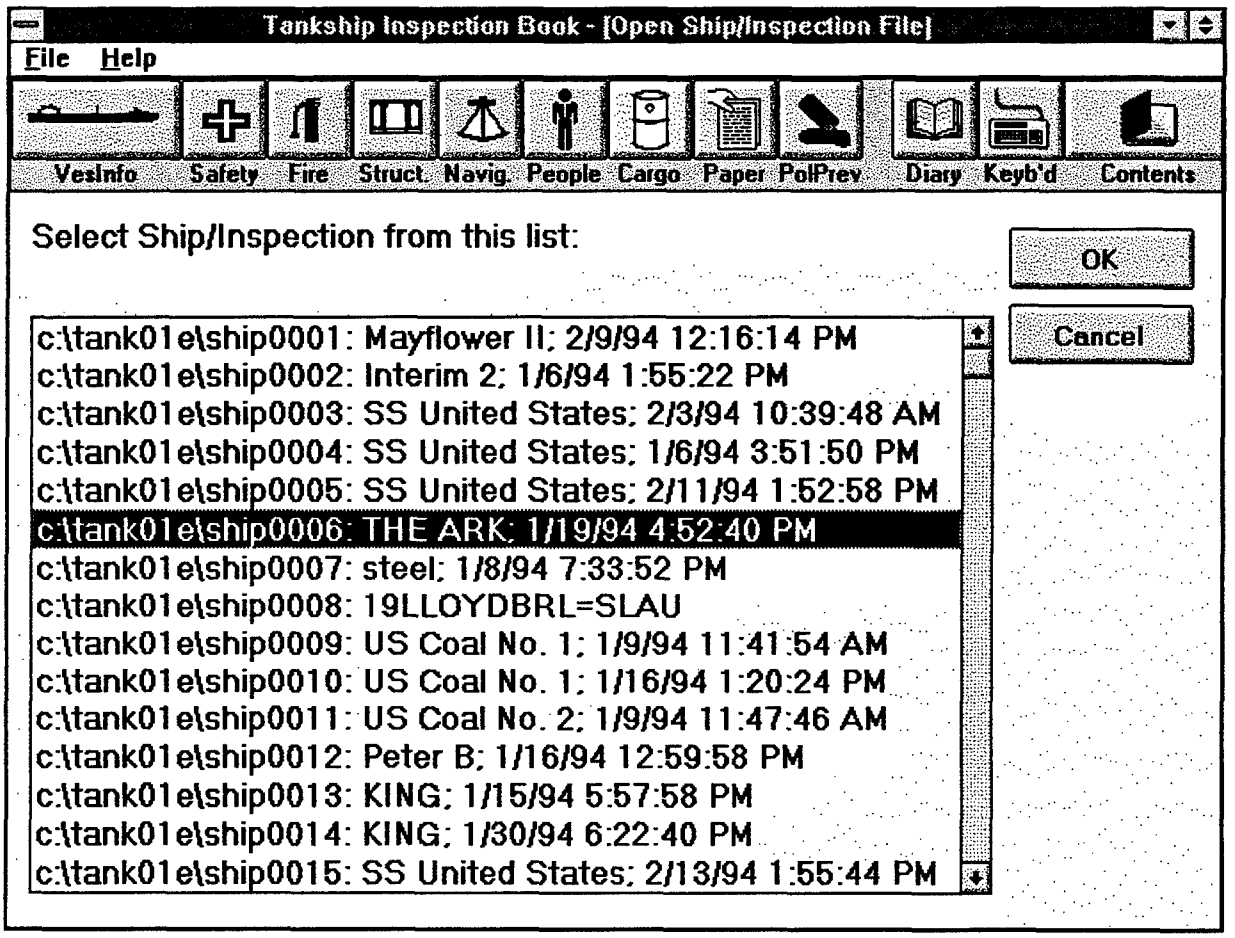

Figure 14 The Open Inspection Screen from the Tankship Program

If a new inspection is selected for a vessel not previously on file, the next screen to appear is the Hull Information Part 1 Second-Level Form. The vessel's name must be entered here before the inspection can continue, and, for tank vessels, the country of registry must also be entered. Once this is done, all other forms are immediately accessible. Figure 15 shows the Hull Information Part 1 screen.

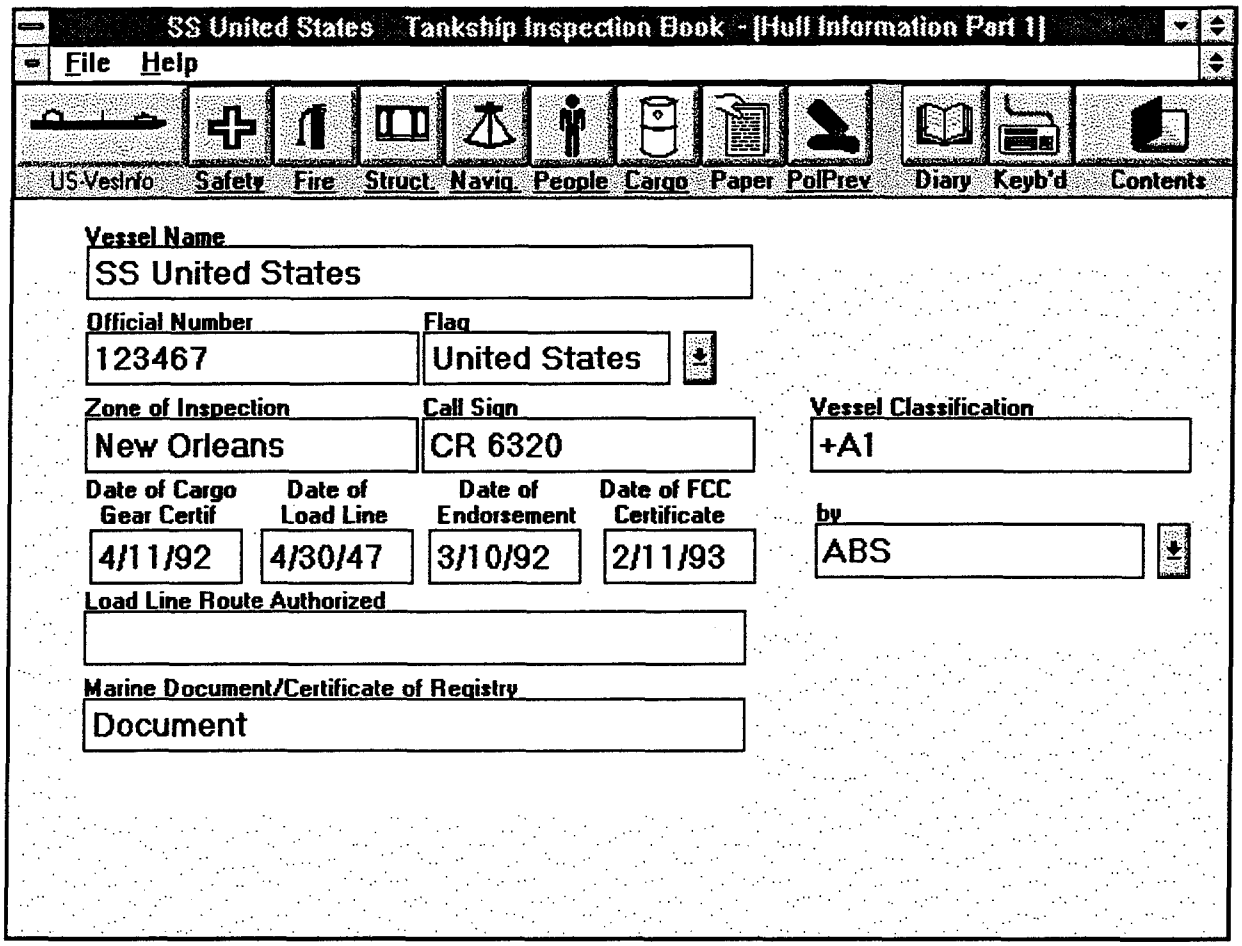

Figure 15 The Tankship "Hull Information Part 1" Second-Level Form

Moving Through the Forms

Once the inspection has been started, the inspector is free to choose any Topic and work down through the First-Level and Second-Level forms to the Third-Level Forms, Comments, and Inks, where most of the actual data entry is accomplished. All movement up and down in the tree structure is accomplished by single taps of the pen. Access is the same as with a paper book; the inspector can partially complete a Third-Level form, switch to another section, then return to finish the form at any time.

Status indicators are provided at the First and Second Levels show the existence of incomplete Third-Level Forms and deficient items. The status indicators for a given Third-Level Form are blank until at least one entry is made in that form.

THE TABLE OF CONTENTS

The Table of Contents (the rightmost icon on the Main Form) provides an alternate method of access to the program. The organization of the MPIU program has been altered from the original inspection books (Parts combined, etc.). However, the TOC for each program is organized exactly like the original paper inspection book with which inspectors are very familiar, and is accessible from any screen except Third-Level Forms, Comment Forms and Ink Forms.

Expanding and Collapsing TOC Levels

The TOC has four levels, three of which can be "expanded" or "collapsed" to increase or decrease the level of detail shown. A (+) next to any line entry can be tapped with the pen to expand into the next level. A (-) next to any item can be tapped to collapse that level. Tapping the text of any line entry jumps immediately to the appropriate form (generally a Second-Level Form). The use of the Table of Contents and the normal method of navigating the program from one level to another can be intermingled at will. Figure 16 shows the Table of Contents in collapsed form; Figure 17 shows part of the TOC in expanded form.

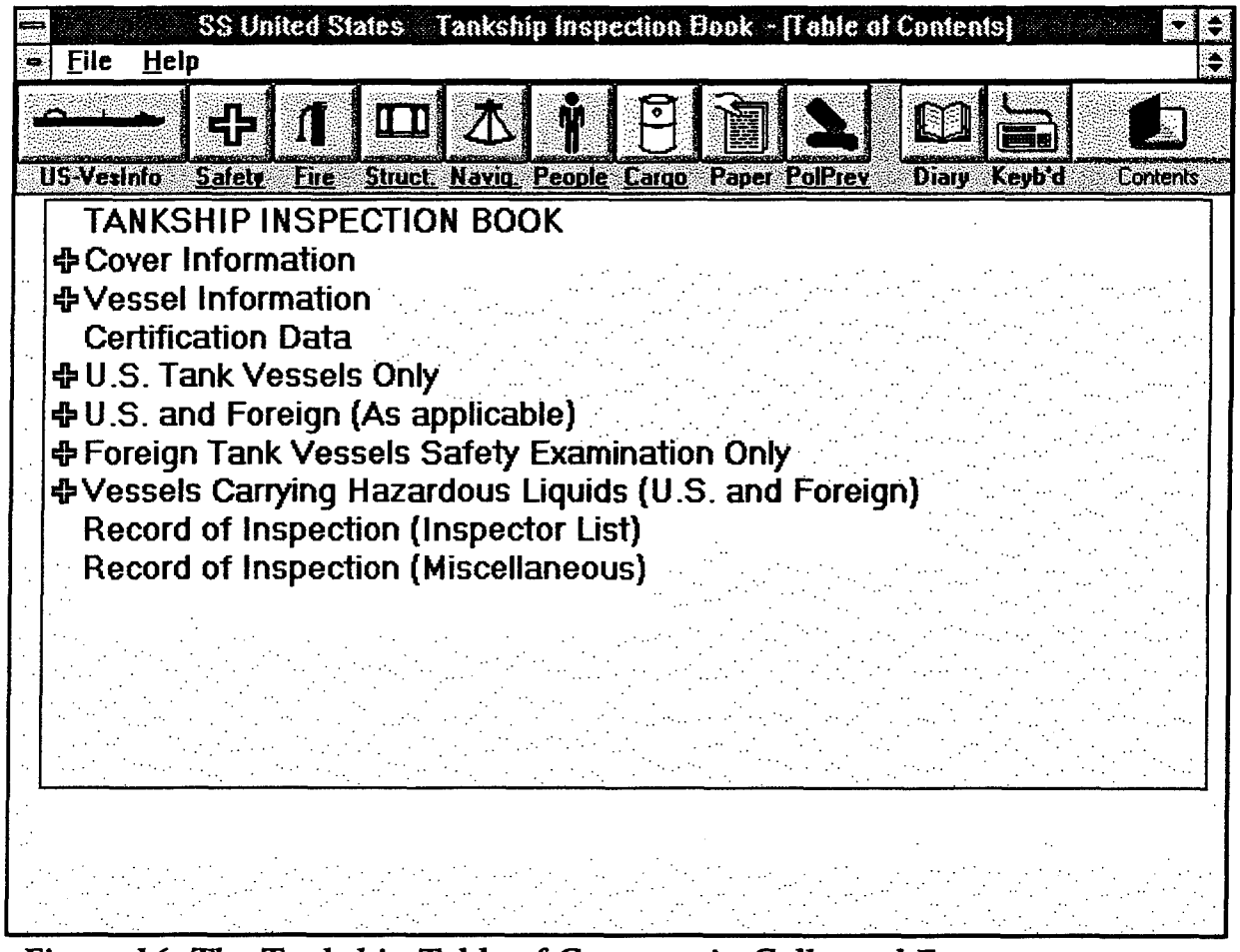

Figure 16 The Tankship Table of Contents in Collapsed Form

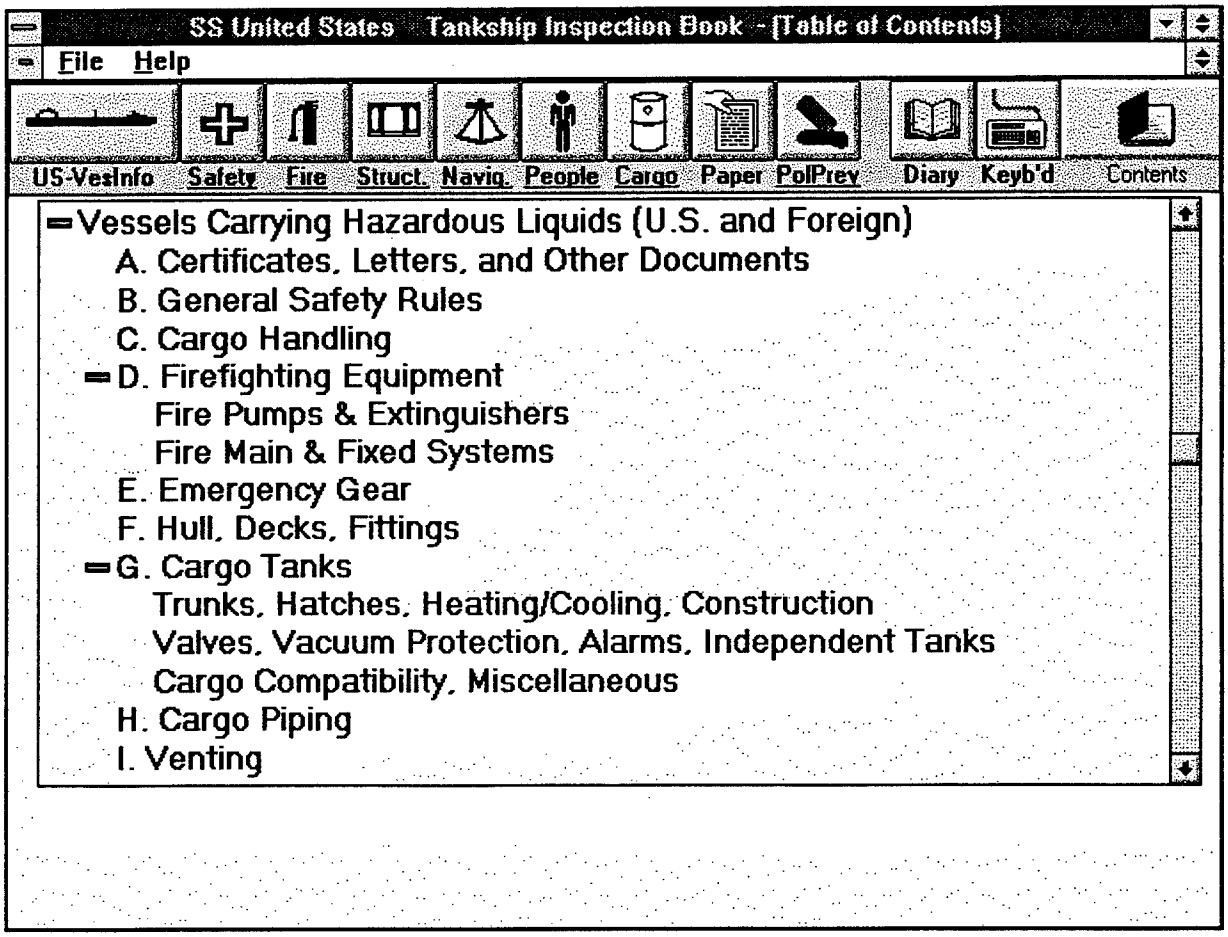

Figure 17 Part of the Tankship Table of Contents in Expanded Form

THE USE AND HANDLING OF COMMENTS

Comments are an important part of the inspection documentation. Recent changes in inspection policy have placed more emphasis on narrative portions of the inspection report. For inspection offices using the "new" inspection documentation procedures which rely primarily on narrative, comments and the inspection diary assume more importance than the simple **"SAT / UNSAT / N/A"** check-off boxes on the Third-Level Forms.

As mentioned above, there are three different types of comments, **"Open"**, **"Cleared"**, and **"General"**, and these three types are treated differently when reports are generated. Open comments are those which indicate outstanding deficiencies, and are generally (but not necessarily) associated with an "UNSAT" check-box. Open comments can be changed to Cleared comments when an originally unsatisfactory condition is corrected before the end of the inspection. General comments are any comments not entered to describe a deficiency, such as an explanation of why an

item was marked "N/A". There is no limit to the number of comments which can be entered for a particular item. At the end of an inspection, for example, a particular entry which is still checked "UNSAT" may have several comments linked to it, some of which may still be open and some which may have been cleared.

In keeping with G-MVI policy, it is anticipated that all **UNSAT** entries will be accompanied by at least a short explanatory comment. Recently revised inspection documentation procedures call for retaining a record of all deficiencies found during an inspection, even if they are corrected before the inspection is completed. In order to implement this policy, the software has been designed to allow comments which are entered in explanation of an **UNSAT** entry to later be **"cleared"** without deleting them. Clearing comments results in the text on screen becoming crossed-out but still readable. Cleared comments are retained as part of the inspection data file, and have a unique status when hard-copy reporting options are chosen.

STATUS INDICATORS

A number of status-indicators are built into the MPIU display. The meanings of some of these are obvious. However, others are more subtle. The subtle ones are explained here:

Vessel Registry Status

The label of the Vessel Info icon on the Main Form reads:
"USVesInfo" for U.S. vessels
"VesInfo" for foreign vessels

Active Inspection Topic

The labels of the Inspection Topic Icons on the Main Form are:
Boldfaced text for the Active Topic
Regular text for the other Topics
(the illustrations in this

Deficiencies

The labels of the Inspection Topic Icons on the Main Form are:
Underlined if there are any items checked **UNSAT**, or **Open** comments, or both, anywhere within a Topic.
Not Underlined if there are no **UNSAT** items or **Open** comments anywhere in that Topic.

Deficiencies and Incomplete (unchecked) Inspection Items

The status indicators **"Complete"**, **"Incomplete"**, **"Deficient"** and **"Def/Incmp"** can appear in the boxes below the Subtopic labels on First-Level Forms and in the boxes next to the Third-Level Form titles on the Second-Level Forms. A Blank box is also a status indicator. These indicators have the following meanings:

Blank
No entries have been made in the underlying material yet. (The underlying fields are not necessarily empty - if a new inspection is started for a known vessel, certain fields which contain information, primarily dates and text, which usually remains the same from one inspection to another are filled in automatically, however, no "SAT/UNSAT/NA" entries are copied). If a Form is opened, then closed again without entries being made, the status remains Blank. If all information (including Checkmarks, Comments and Inks) are deleted from a Form which previously contained information, its status is changed to Blank.

Complete
No **UNSAT** checks, no unchecked entries, and no **open** comments in the underlying forms. The "Complete" message also appears initially on the Second-Level form for Third-Level Forms which are completely deactivated because of the registry of the vessel. (The information on some Third-Level forms applies to U.S. vessels only). Note that comments can still be entered for inspection items on deactivated Third-Level Forms. An Open comment entered for a deactivated Third-Level Form item results in a "deficient" status indication at the levels above.

Incomplete
At least one unchecked entry, but no **UNSAT** checks or **open** comments in the underlying Forms.

Deficient
At least one **UNSAT** entry or **open** comment, but no **unchecked** entries in the underlying Forms.

Def/Incmp
At least one **UNSAT** entry or **open** comment and at least one **unchecked** entry in the underlying Forms.

Status information is retained in a special file called "SUMMARY.DAT" in each inspection directory. This allows the correct display of status information when an inspection in progress is reopened.

The Active Item

The Active Item on a Third-Level Form is indicated by a **boldface** label. The "**Ink m/n**" and "**Cmt m/n**" indicator buttons and the "**New Ink**" and "**New Cmt**" buttons at the top of the form apply to the Active Item. In the Third-Level Form shown in Figure 9, for example, the Item "Foam and chemicals container" is the Active Item.

The Existence of Comments or Inks for the Active Inspection Item

The "**Ink m/n**" and "**Cmt m/n**" indicator buttons at the top of the Third-Level Form indicate the existence of Inks or Comments for the Active Item. The number "**n**" is the total number of existing Inks or Comments for the Active Item. The number "**m**" is the index number of the last-edited Ink or Comment. Tapping the "**Ink m/n**" or "**Cmt m/n**" buttons opens the Ink or Comment indicated by the index number. (Other existing Inks or Comments can then be opened using the "**Next**" button on the Comment or Ink forms.)

The Existence of Inks or Comments for all Inspection Items on a Third-Level Form

The existence of Inks and/or Comments for Inspection Items on a Third-Level Form is indicated by the indicators **C** and/or **I** to the left of the checkboxes for each Item.

If there is at least one comment and/or Ink linked to an individual inspection item on a Third-Level Form, the letters "C" and/or "I" appear next to the checkboxes for that label.

THE USE OF THE "SAT / UNSAT / N/A" CHECKBOXES

The use of the "SAT / UNSAT/ N/A" checkboxes on the third-level forms is entirely optional. Inspectors working in offices using the "New" inspection documentation procedures in which narrative descriptions are the primary record may prefer not to use the checkboxes. If no checkboxes are used, the status indicators on the Second-Level and First-Level Forms will indicate "INCOMPLETE" - these indicators can be ignored. If the incomplete status messages are annoying, all items can be checked "NA". As long as open comments are entered for all Deficiencies,

the status indicators on the Second-Level and First-Level Forms and on the Main form will indicate properly; an item with one or more open comments is treated in the same way as one with an "UNSAT" checkmark, regardless of the state of its checkmark. (An item with no open comments, but an "UNSAT" checkmark, is also considered deficient).

Any Inspection Item for which an Open comment exists at reporting time will be listed on Deficiency reports. If the UNSAT checkbox is not checked, then the "USat" message will not print with the Item when it is listed on the report, however, the existence of an Open comment will be indicated, and this indicates an open deficiency, regardless of the checkbox state. (Even if the SAT or N/A checkboxes were checked, any item with an Open comment would be treated as an open deficiency during report generation).

ENTERING TEXT AND DATES

Handwriting Recognition

The Windows recognizer will convert printed ink characters into text. Uppercase and lowercase printing and standard punctuation is recognized. The recognizer has a somewhat easier time recognizing lowercase text than uppercase.

The "Pen" and "Handwriting" settings in the Windows Control Panel control the appearance of ink and also control a number of important text recognition parameters. The settings in the "Pen" section are similar to mouse configuration in the standard version of Windows, with the addition of ink width and color. The settings in the Handwriting section allow selection of customized recognizer configurations for different users. These configurations can be modified with the Pen Trainer program in the can be customized for individual users and saved as separate configurations for a number of different users. A drop-down selection box is used to select the desired configuration, which is generally identified by the user's name.

The Trainer option of the Pen Palette program allows the recognizer to adapt to individual users. If a letter is not recognized, the user can use the keyboard to enter it and instruct the system to recognize it in the future. The training settings are saved with the configuration for the currently selected user. The "advanced" option of the trainer allows the user to view and edit the recognition database, a list of ink shapes which are converted into specific characters. The changes made here are saved in the configuration file for the currently selected user.

Text Entry Methods

Text entry boxes appear on many forms. There are several options for entering text:

Keyboard If a keyboard is attached to the computer, this is certainly the easiest way to enter text. The pen still functions completely when a keyboard is attached.

Direct Entry The text can be printed directly on a text box with the pen.

The Edit Gesture Entering the "edit" gesture (a large check-mark) in a text box brings up the Text Entry Form, which appears with several lines and "combs" to separate the letters. The system is more effective at recognizing characters printed into a Text entry form than text entered directly into a text box on a screen form, since the separation of characters is strictly defined by the combs and the size is controlled. Lower-case letters are somewhat more easily recognized than upper-case, so use lower-case whenever possible. Punctuation marks often cause trouble.

The On-Screen Keyboard The on-screen keyboard, accessible from the keyboard icon on Main Form and from the Text Entry Form, shows a standard typewriter keyboard on the screen, from which letters can be selected by single pen taps. Figure 18 shows the On-Screen Keyboard Superimposed on a form.

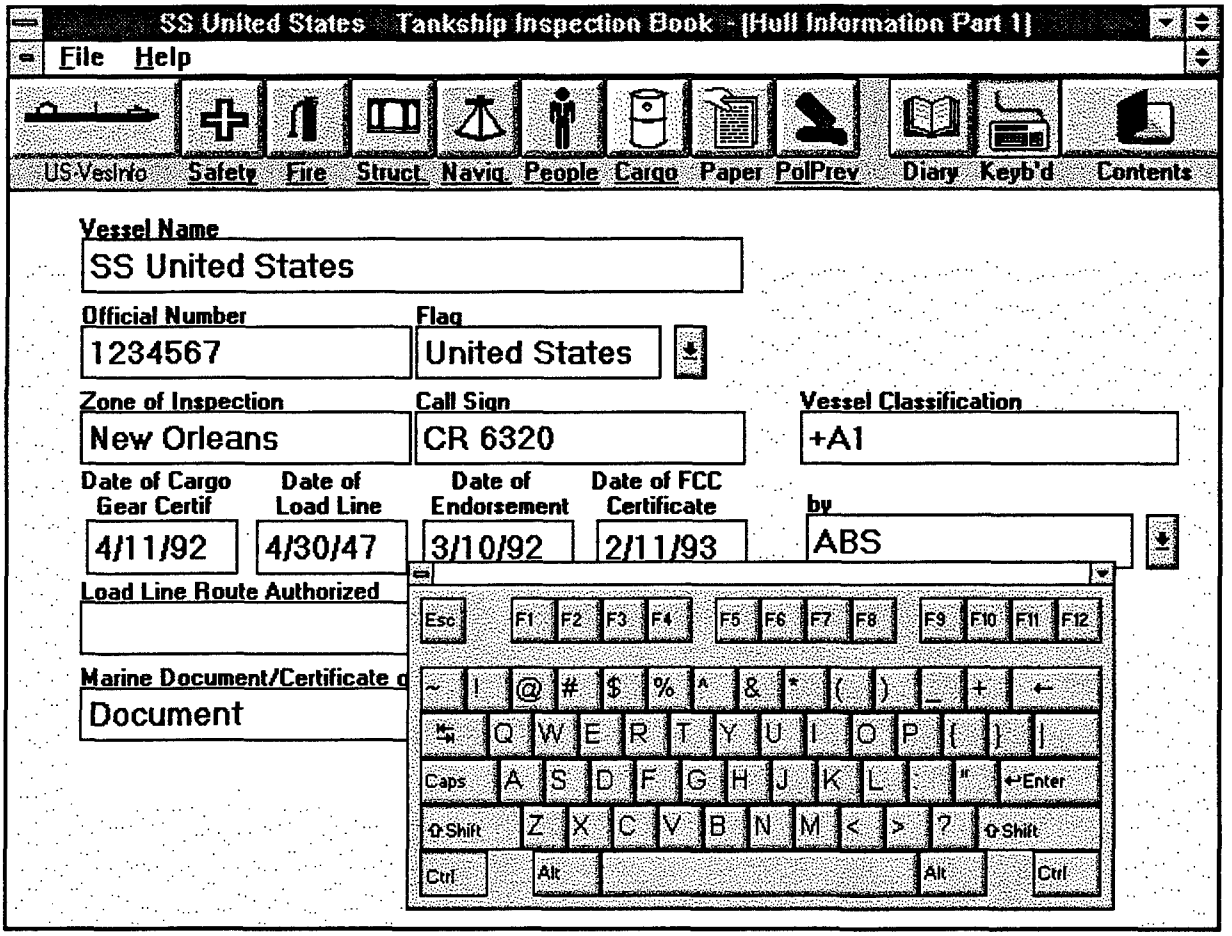

Figure 18 The On-Screen Keyboard

Date Entry

Tapping once in a Date Box brings up the Date Edit Form, which allows entry or editing of dates by single pen taps for the day, month, and year. The result shows on a comb-divided text entry line at the bottom of the form, where it can be edited, if necessary before being sent to the Date Box. The Date Edit Form automatically displays the most recently entered date when it appears. Clicking on an existing date brings up the Date Edit Form with the selected date ready for editing. Figure 19 shows the Date Edit Form.

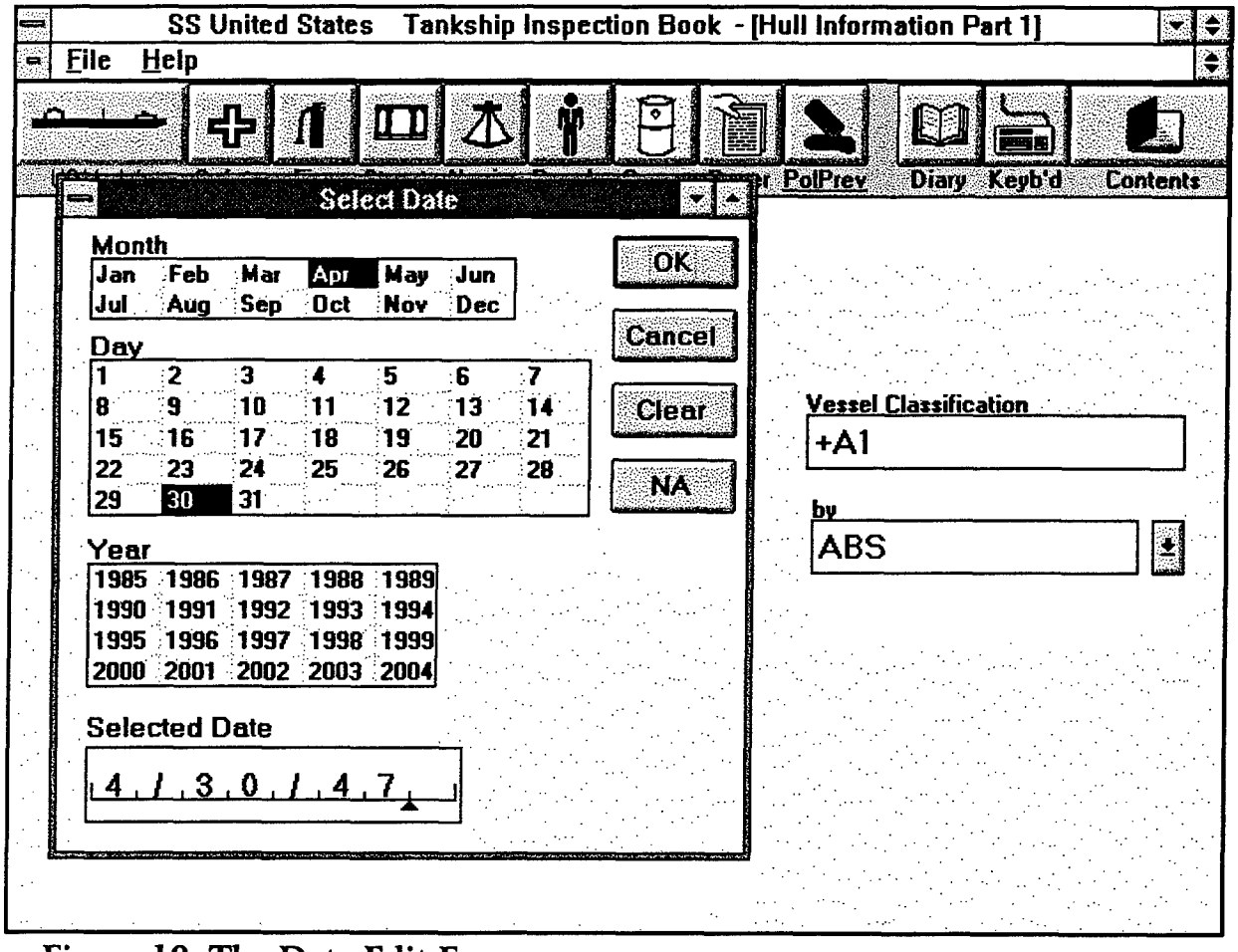

Figure 19 The Date Edit Form

REPORT GENERATION

While this project is hopefully a step in the direction of "paperless" inspection documentation and record-keeping, the present system still depends upon paper reports. Consequently, a flexible report-generation facility has been incorporated into the program. The reporting system can print a report directly, including sketches and digital photos, in a simple format, and can send the text portion of the report to Windows Write for on-screen display, editing. formatting, and printing.

The standard report format lists the requested information in the left-to-right order of Inspection Topics. Within topics, information is listed in the top-to-bottom order of sub-topics, inspection categories, and individual inspection items. Each Inspection Item corresponding to the selected report type occupies one line on a report. On

this line, the Status (SAT/UNSAT/N/A), the item label, and the existence and type of comments and inks linked to that item are reported.

Report options are entered in the Report Options Dialogue Box, which is reached by the **File - Print** commands from the Main Menu. Figure 20 shows the Report Dialogue Box.

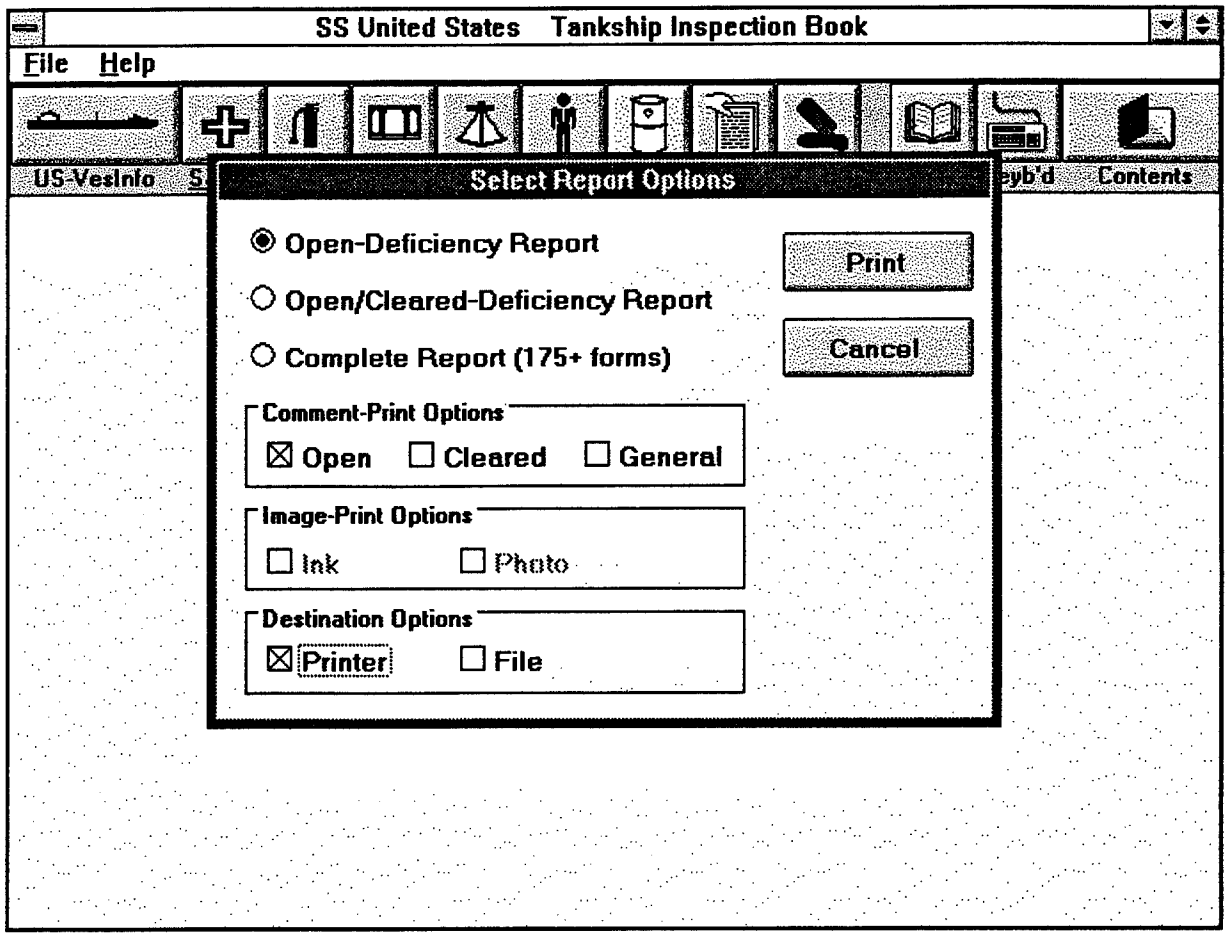

Figure 20 The Report Dialogue Box

Types of Reports

The three basic types of reports and the information contained in each of them is listed below:

1 Open-Deficiency Report

A listing of all inspection items checked UNSAT on Third-Level Forms. Items which are not checked UNSAT but which have open comments linked to them are printed in this report, as well.

2 Open/Cleared Deficiency Report

A listing of all inspection items checked UNSAT, and all items which are checked SAT or N/A but which have open or cleared comments linked to them, indicating that they were UNSAT at some point during the inspection. AS with the report above, items which are not checked UNSAT, but which have open comments linked to them are included.

3 Full Report

A listing of all Inspection Items and their status (SAT, UNSAT, N/A).

The Full Report also includes the contents of the Vessel Information and Record of Inspection Forms.

Printing of Comments and Inks

There are several options for the printing of Comments and Inks. These options are independent of the Type of Report being printed. Any combination of Open, Cleared, and General comments can be selected with any of the three types of report. The selection of Comments is made by checking three boxes in the Report Options dialogue box.

Inks are also selected for printing by two checkboxes in the Report Options dialogue box. Sketch Inks and Photo Inks are separately selected.

When Comments and/or Inks are selected for printing, they will be printed immediately following the line for the Inspection Item to which they are linked. If General or Cleared comments are selected for printing, Inspection Items which

have these comments linked to them will be printed even if the items would not normally be printed for the type of report selected. For example, if General comments are selected for printing with an Open-deficiency or Open/Cleared Deficiency Report, Inspection Items which are checked "SAT" or "N/A", and which have General comments linked to them will be printed, even though "SAT" and "N/A" Items would not normally print in this type of report.

Report Format

Each page of a report has a Title line containing the vessel name, the type of report, the date and time of the inspection (that is, the date and time of creation of the inspection file), and the page number in the report.

The basic report format prints a paragraph for each Third-Level Form which contains the requested types of entries. The paragraph begins with a header line indicating the names of the Inspection Topic, the Second-Level Form or subtopic, and the Third-Level Form or inspection category. Indented after the header are lines for each inspection item which has a status matching the requested report type. Each item line contains the status of the item, the name of the item, and the number and type of comments and sketches linked to that item.

The general format of a report paragraph is shown below:

Inspection Topic: *2nd Level Form Name*: *3rd Level Form Name*
Status *Item Name* *text or date* (oc:[*# open cmnts*] cc:[*# cleared cmnts*] gc:[*# general cmnts*] lnk:[*# sketches and photos*])
Status *Item Name* *text or date* (oc:[*# open cmnts*] cc:[*# cleared cmnts*] gc:[*# general cmnts*] lnk:[*# sketches and photos*])
etc. (up to eight items per third-level form

The example below shows a typical paragraph (representing one Third-Level Form) for an Outstanding-Deficiency Report (Type 1 above)

Structural: Hull, Decks, and Fittings: Valves and Controls
USat Overboard discharge valves (oc:2 cc:1 lnk:1)
Emergency shutoff valves (oc:1)
USat Pollution prevention (oc:3 gc:1)

Comments and Inks print immediately after the Inspection Item with which they are associated.

Report Output

There are three options for the destination of a report, all accessible from the **File - Print** and **File - Printer Setup** commands:

Direct Hardcopy

Reports can be printed immediately if the printer is connected to the computer. Select the printer from Printer Setup (DeskJet 310 for this project), then select Print, then check the box for "Printer". The report will be printed immediately.

Delayed Hardcopy

Reports can also be printed to a Printer File. (A Printer File contains all of the print commands for the selected printer and can be printed merely by copying the file to the printer from DOS as if the printer were a file, i.e. "COPY <filename> PRN".) To do this, select "HP DeskJet Portable Printer on File" from the Printer Setup dialogue box, then check the "Printer" box in the Print Dialogue Screen, enter a filename at the prompt, then print. The files are placed in the program directory, which is C:\TANKSHIP for tankships and C:\BARGE for barges. Care should be taken in naming and managing these files, to avoid overwriting existing files.

Printing to a DOS Text File

Reports can be written to a DOS text file (ASCII) which can be viewed, edited, and printed with Windows Notepad, the MS-DOS Editor, Windows Write, or any other text editor. To do this, check the box marked **"File"** in the Print Dialogue Box, then print. Both the **"File"** and **Printer"** boxes can be checked, resulting in a hardcopy (or a printer file) and a text file of the report. The DOS text report files will are stored in the inspection directory under the name RPTxxxx.TXT. The number xxxx is incremented each time another report file is generated.

Treatment of Inks in Printer and DOS Text Files

A Printer File of a Report contains all formatting, such as page breaks, which are calculated by the software for a particular printer, and it contains Ink, but not photos. Photos are printed when a printer file is printed if the photo files are in the same directory as the printer file. The DOS text file of a report cannot contain Ink or photos. A DOS text file is mainly intended for incorporation into word processing documents or for use when a report is to be printed on a printer not defined in the MPIU system. Figure 21 shows the Printer Setup Screen.

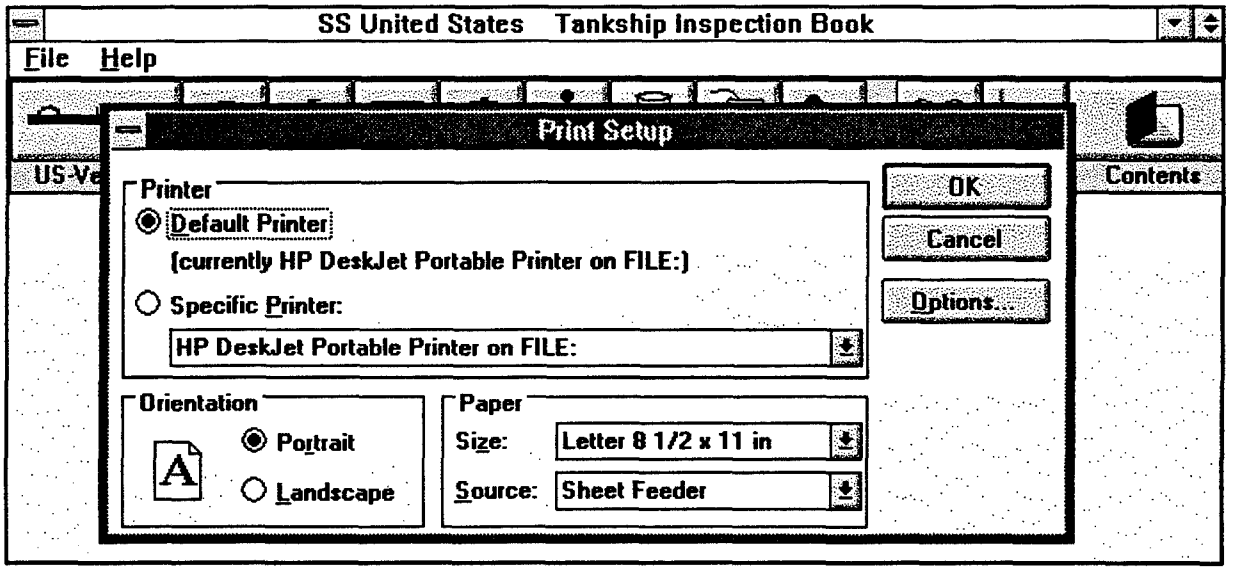

Figure 21 The Print Setup Screen

THE ROUGH DIARY

The rightmost button on the Main Form, labelled "Diary", leads to a text entry form, on which comments can be entered. The comments entered here are not linked to any specific inspection items. The Diary Form is intended to be used as a scratchpad for miscellaneous comments which will form the basis of the inspection diary. The diary is stored as a separate text (ASCII) file (DIARY.TXT) in the inspection directory. This file is reloaded each time the Diary Form is entered, and is updated each time the diary is exited. After an inspection is completed, the diary file can be imported directly into a keyboard-based word-processing program for editing and expansion into the final "smooth" diary.

Comments and Inks associated with individual Inspection Items can be copied, through the Windows Clipboard, into the smooth diary as well, so there is no need to duplicate in the rough diary any material which is included in linked comments. Figure 22 shows the Diary Form.

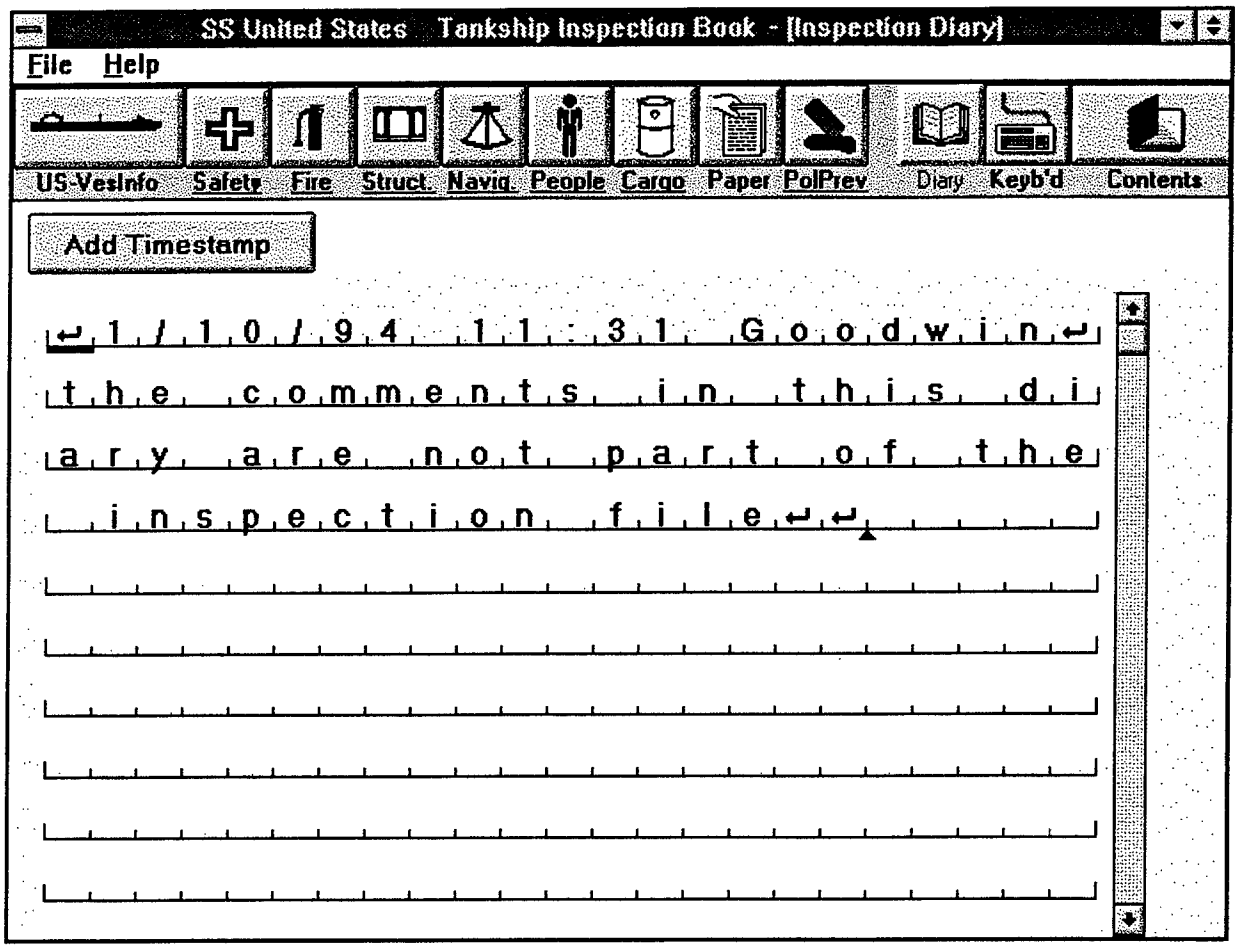

Figure 22 The Diary Form

The size of the Rough diary is limited to 32K bytes, or about 16 pages of standard typewritten text. The screen display of the rough diary generally only shows a few empty lines past the end of the existing text, but more space will appear as text is entered. In the unlikely event that the 32K size is reached, save the inspection file (from the Main Form File menu), minimize the MPIU program (but do not exit), start File Manager, and rename the file DIARY.TXT in the inspection directory to DIARY2.TXT or some other suitable name. Then restore the MPIU program, delete any text showing in the rough diary, and continue. The continued diary will be placed in a new file DIARY.TXT. This renaming of inspection files during execution of the program is possible because the MPIU program leaves no files open. Files are opened during saves, then closed again immediately for protection in case of power interruptions, inadvertent resets, or damage to the system.

THE HELP PROGRAM

The on-line MPIU Help Facility is a full-scale Windows "hypertext" help program. All functions of the MPIU software are explained in the help file. Underlined words are "hot words"; tapping a hot word jumps immediately to a screen explaining that word. Help is available from any screen in the MPIU program. The Help files for the Tankship and Barge programs are slightly different. Figure 23 shows the first page of the MPIU Tankship Help program.

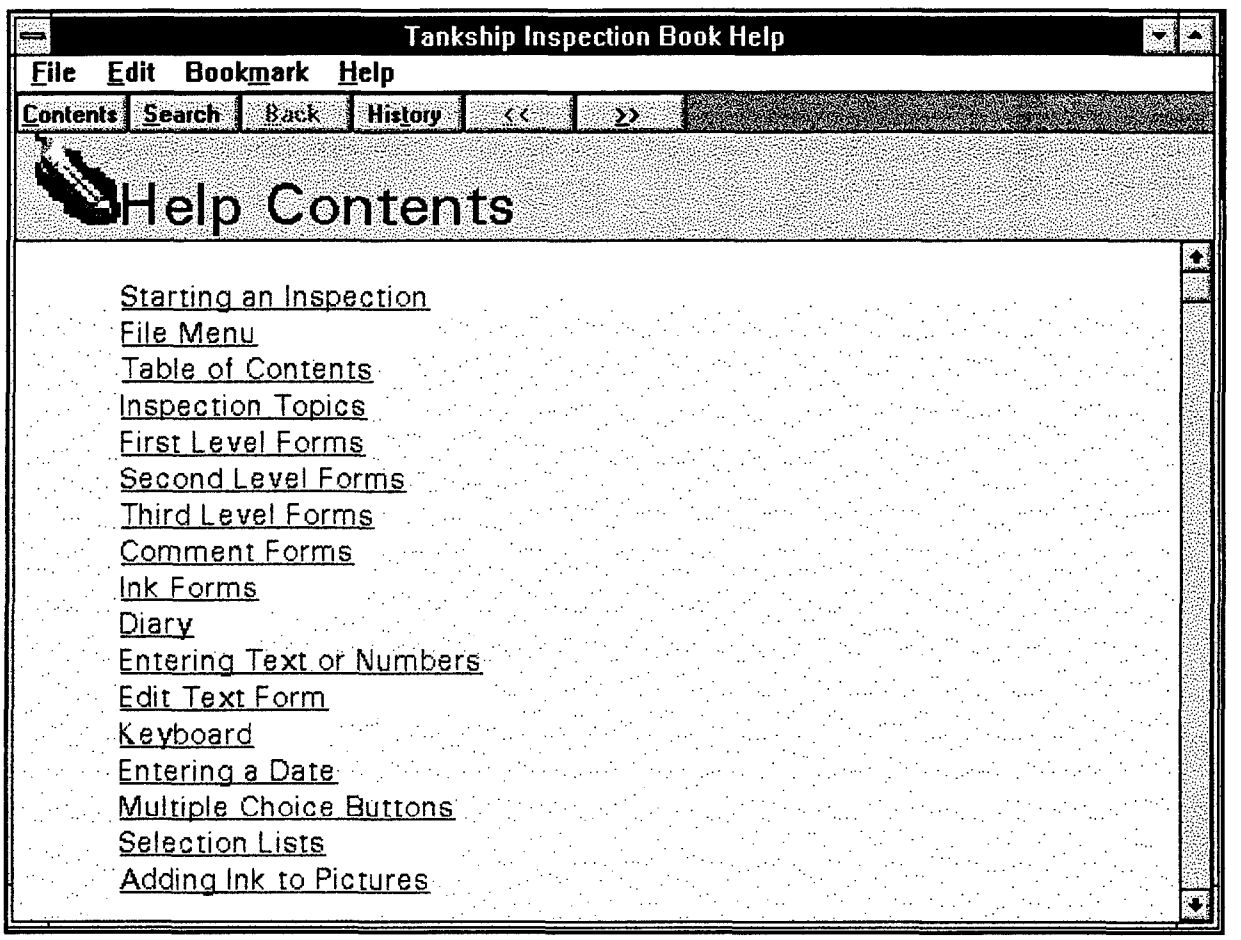

Figure 23 The Contents Screen of the MPIU Tankship Help Program

MERGING INSPECTION FILES

In some cases, more than one inspector may conduct an inspection. The hardware and software supplied for this pilot project allows two independent inspectors to conduct parts of the same inspection using the two pen-computers. A merge facility built into the software allows two independent inspection files of the same inspection to be merged into one coherent file.

To merge two parts of one inspection, either the inspection files to be merged must be located on one computer (but in different directories or drives, including floppy drives), or the machines must be connected together with Interlink.

The MPIU program (Tankship or Barge) is opened, one file of the inspection is opened normally and The **Merge** option is selected from the **File** menu. The drive and, if necessary, the directory containing the subdirectory for the desired inspection are selected. The program will find all inspection directories in the selected location which contain inspection files for the ships having the same name as the ship of the presently open inspection file. The proper inspection is selected, and the merge process begins. Figure 24 shows the Merge Screen.

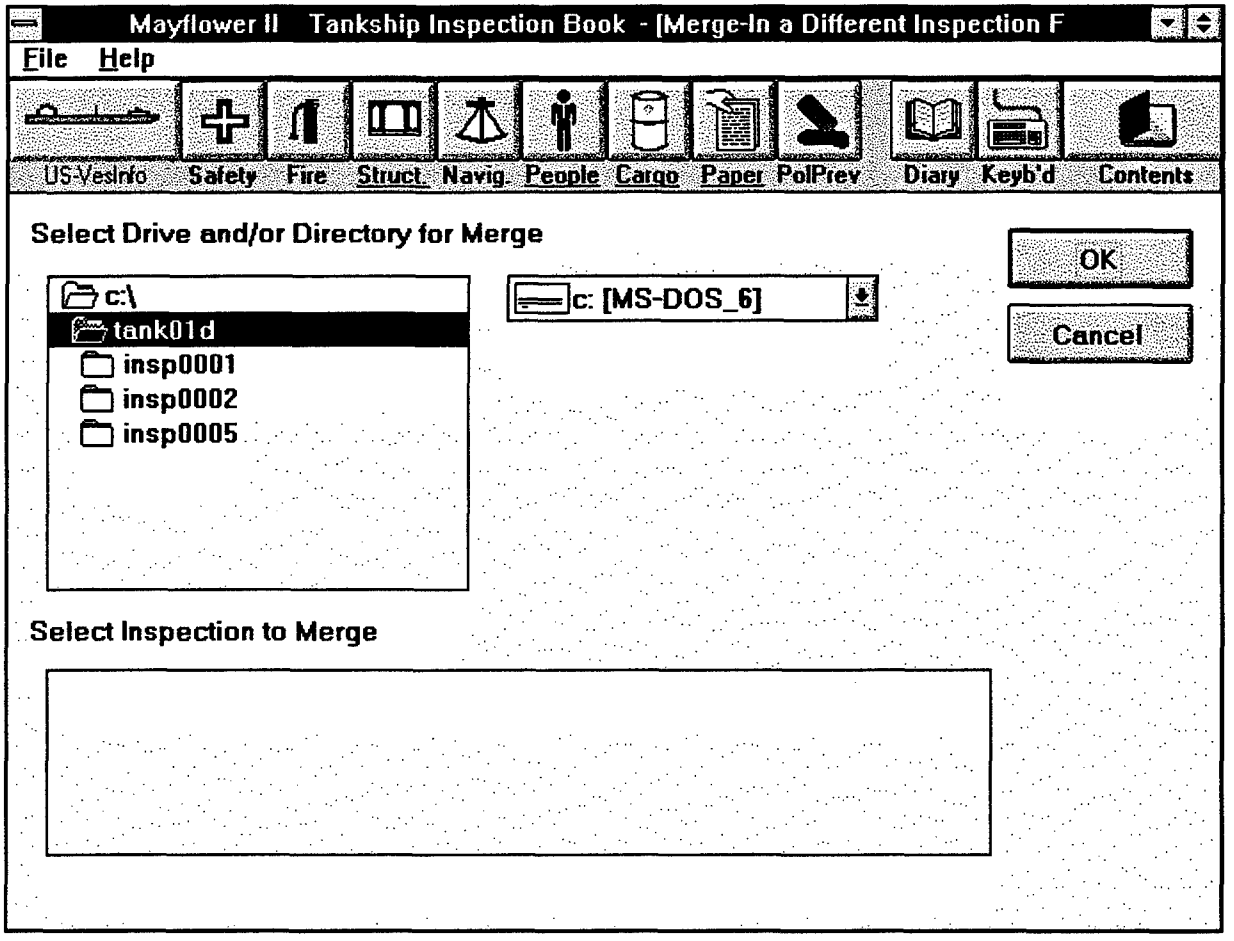

Figure 24 The Merge Screen

The majority of the merging will happen automatically according to the following rules:

1 A **SAT** and an **UNSAT** check for the same inspection item are combined into an **UNSAT**, without user intervention being necessary.

2 A **SAT** and a **SAT**, an **UNSAT** and an **UNSAT**, and an **N/A** and another **N/A** are combined into a single **SAT**, **UNSAT**, or **N/A**, respectively, without user intervention.

3 If an **N/A** check and either a **SAT** or an **UNSAT** occur together, the user is prompted for clarification.

4 Comments and Inks are simply appended, without user intervention

5 If unmatched entries occur in text entry boxes or date entry boxes, the user is prompted for clarification.

6 Diary files are appended.

When clarifications are necessary, a special screen will appear, which shows the two (or more) entries, and allows the user to delete those which do not apply or are incorrect, and to edit any entry. Comments and Inks associated with items needing clarification are available for viewing from the clarification screen, to assist inspectors in making the correct decisions on resolving the issue.

Duplicate entries which need clarification need not be resolved immediately; the database has the capability of storing multiple entries for any item, even though their existence may be confusing. Any time an inspection containing duplicate entries is opened, the user will be warned about this condition, and the **Eliminate Duplicate Entries** command on the **File** menu will be activated (it is normally grayed out). The inspector can resolve some or all duplicates immediately after opening an inspection containing them, or can wait. The **Eliminate Duplicate Entries** command remains accessible at any time from an inspection containing duplicates. When this command is selected, the clarification screen will come up.

RUNNING MORE THAN ONE INSTANCE OF THE MPIU PROGRAM

It is possible to run more than one instance of the MPIU program. This might be useful in the office for viewing and comparing inspection files of sister ships to identify class problems. However, the principal use for this capability would be to have the records of a previous inspection of a vessel running for reference during a reinspection. During the pilot program, this is not likely to happen because there will be no previous inspection files, however, once the system comes into wider use, this technique may prove useful. It is analogous to carrying a copy of the inspection book from a precious inspection while conducting a reinspection.

It is anticipated that when the MPIU system is fully implemented, once an inspection has been completed and validated, the record of that inspection will be "read-only". In the read-only state the MPIU screen display of a completed inspection will allow the user full access to all forms to view the results of the previous inspection, but all new entry of checkmarks, text, and ink will be disabled, and the inspection data file will be locked to prevent it being changed. In theory, any number of past inspections (2 years ago, 4 years ago, etc.) could be running simultaneously for reference purposes, subject to system resource limitations.

In order to run two instances of the program, start the MPIU program from the MPIU Group in File Manager, and start an existing inspection of a particular ship. Then minimize this version of the program. Now start the MPIU program again,

and start a new inspection of the same vessel. Using the Control-Button pulldown menu, you can now switch from one instance to another. Experienced Windows users will also be able to split the screen and display both programs at once, although some of the display is obscured when the program is not running in full-screen mode.

Application-switching is treated like any other function of the Main Form, and is therefore not available from Third-Level Forms, Comment Forms, or Ink Forms.

MPIU FILE AND DIRECTORY STRUCTURE

THE INSPECTION DIRECTORIES

While a knowledge of the program structure is not necessary for the user, a few details of how the MPIU program stores information may be helpful.

When a new inspection (either of an unknown or previously inspected vessel) is begun, the MPIU program automatically creates a separate subdirectory for the data files of that inspection. These directories are named by the program in numerical order as "C:\TANKSHIP\INSP0001", "C:\TANKSHIP\INSP0002", etc. for Tank Vessels, and "C:\BARGE\INSP0001", "C:\BARGE\INSP0002", etc. for Barges. Inspections in progress of a particular vessel, even if stretched over days or weeks, continue to use the same directory and files.

THE INSPECTION DATA FILES

The principal inspection data file in each INSP directory is **INSP.DAT**. INSP.DAT is an ASCII data file, and it stores the results of all checkbox entries, the contents of Comment forms, and Ink from sketch and photo Ink Forms. The other files in the inspection directory are:

SUMMARY.DAT This file stores the status indicator states for the Main, First-Level, and Second-Level forms, so that inspections in progress can be reloaded with full status information available.

INSP.BAK The most recent previously saved version of INSP.DAT.

DIARY.TXT A standard text file (ASCII) containing the contents of the rough inspection diary which is opened from the Diary Icon on the Main Form of the MPIU program.

RPTxxxx.TXT A standard text file (ASCII) containing the inspection reports printed to a file by using the "File" checkbox in the Print Dialogue Screen. These are numbered sequentially (xxxx) and you can make as many different ones as you want. However, a proliferation of report files for one particular inspection will eventually become confusing and hard to keep track of.

SAVING FILES

The MPIU program does not leave any data files open during an inspection. Files are opened momentarily for the reading of data when an inspection is loaded, and are again opened momentarily whenever the user chooses the **Save** or **Exit** options from the File menu. Having no data files open is a valuable safety feature preventing accidental corruption of files resulting from accidents, improper battery hot-swaps, or other power losses.

The principal inspection files, INSP.DAT, and SUMMARY.DAT are saved automatically whenever a normal exit is made from the MPIU program or when a new inspection file is opened. In addition, most errors which can cause the program to halt will result in a save. Files can also be saved manually by choosing the **File - Save Ship/Inspection** commands. It is recommended that a manual save be made before hot-swapping batteries.

MOVING INSPECTION DATA FILES TO ANOTHER COMPUTER

If the occasion arises to move files from one computer to another, be very careful to avoid moving the wrong file or overwriting files inadvertently. The files INSP.DAT and SUMMARY.DAT have the same name for all ships; the only easy way to tell different ones apart is by the directory in which they are stored by the program, and possibly by the file date.

If it becomes necessary to positively verify the identity of a file, INSP.DAT is a standard ASCII text file and can be viewed by using the MS-DOS TYPE command. The syntax is TYPE <filename.dat> | MORE from the DOS prompt (Note that the DOS Prompt is not available from windows for pen-computer which are not connected to their keyboards). The first line of the file includes the name of the ship and the date of the inspection (the date of creation - the date when the inspection file for that ship was first opened). These two lines uniquely identify an inspection. INSP.DAT can also be viewed with the Windows Notepad ASCII text editor or with Windows Write using the no-conversion option.

Moving a Record to Continue an Inspection In Progress

To move an inspection record to another computer to continue an inspection in progress on the other machine, you must first find the correct file. To do this, start the MPIU program on the source computer, and from the File menu, scan the list of available inspections for the desired ship/date desired. Note the directory name next to the ship name and date. Then create a directory named "C:\TANKSHIP\SHIPxxxx" or "C:\BARGE\SHIPxxxx" on the target computer, where xxxx is the number following the highest-numbered existing inspection directory on the target computer. Then, copy the files INSP.DAT and

SUMMARY.DAT from the source machine to that directory. When the MPIU program is started, the desired inspection should be available from the list shown by tapping **File - Load Ship/Inspection.**

Moving a Record to Start a New Inspection

To move a record to another computer to start a new inspection of a previously inspected ship, the same procedure can be followed, but only INSP.DAT is required. The file INSP.DAT contains the entire record of a previous completed inspection. When a new inspection is started for the ship on the target machine, a new directory is created, and a new version of INSP.DAT is created in that directory. This new version contains only that information from the previous inspection which is considered not to be time-sensitive, and is thus much smaller than the INSP.DAT for the previous complete inspection.

Alternatively, the new, smaller, INSP.DAT file can be created on the source machine by opening a new inspection for the previously inspected ship. Using the File menu, the directory name for this file is identified, and then the relatively small new-inspection file INSP.DAT is copied to the target machine.

PHOTOGRAPH FILES

Digital photographs are downloaded from the digital camera to the inspection directory by use of the LogiTech FotoMan program. The Icon for this program is in the MPIU group in File Manager, and it can be run concurrently with the MPIU program by minimizing MPIU.

Once the photographs are placed in the inspection directory, they are available to be linked to Ink forms by the MPIU program. Not all of the photos downloaded will necessarily be linked, and some may be linked to more than one Ink form. Photos linked to Ink Forms are not stored as part of the INSP.DAT file; that file only contains references to them. This keeps the inspection data file to a reasonable size and makes it possible for more than one Ink form to use the same photo without increasing the need for storage space. Photographs are stored in the inspection directory with file extensions ".BMP".

Photos take a lot of space, and moving them by floppy disk can be a lot of work. One load of photos (32) from the Logitech Fotoman camera consumes about 6MB of disk space, and would require four 1.44MB 3.5" floppy disks. If photograph files need to be moved, it should be done with the MS-DOS Interlink program.

ACCESSIBILITY OF INSPECTION RECORDS

The file copying techniques explained above may eventually be used to transfer information from one inspection office to another for background information and for setting up new inspections of previously inspected vessels. File accessibility will even allow continuation of an inspection in progress by a different offices if a ship moves during the course of an inspection. The same procedures may be used eventually to move inspection records to and from the Coast Guard Marine Safety database (Now the MSIS, eventually to be the new MSN). Note that once the inspection files (INSP.DAT) for past inspections are in the database, the complete records of a vessel's past inspections will be immediately available to all inspection offices worldwide. A floppy disk containing the latest version of the INSP.DAT file for a vessel might also be stored on board the ship, in effect replacing or supplementing the Bridge Record Card.

RUNNING THE MPIU PROGRAM ON OTHER COMPUTERS

The MPIU program is written specifically to run on pen-based computers using Windows for Pen Computing. However, many inspectors have their own laptop computers and may want to use the program on their own machines. This can be done, but it requires manual changes to the computer's configuration. The IBM laptop included in the MPIU system has been configured this way.

The difference between Windows for Pen Computing and Windows 3.1 is the existence of several support files referred to as the Pen Computing Extensions. (Windows 4.0, which is due in late 1994, will incorporate pen support without requiring any additions). Once the appropriate changes have been made, the MPIU program will run on a laptop or desktop computer with the following requirements and differences:

1 The computer must use a 386 or higher processor, and run Windows 3.1 in 386 enhanced mode.

2 In order for existing Ink in a file to be visible on the screen of a non-pen-based computer, a special screen driver (limited to 640x480 resolution) must be installed. Additionally, in order for new ink to be created with the mouse a special mouse driver must be installed. Since laptop and desktop computers have keyboards, there is no need for text entry with mouse ink, however, for ink sketching to be available, this configuration is required. Inking with the mouse is fairly difficult and is a poor substitute for pen inking. Handwriting recognition of mouse ink by the system is poor at best. In addition, with this mouse driver installed, normal mouse operation is significantly degraded.

The normal mouse driver can be used with the special screen driver; ink will be visible, but new ink cannot be created. This configuration is probably the best for laptop and desktop users wishing to try out, practice with, or demonstrate the software.

3 Mouse or trackball left button clicks are used for all pen taps.

INSTRUCTIONS FOR INSTALLING THE PEN EXTENSIONS

For a minimal installation:

The MPIU program will run, existing ink will be visible on the screen, and the mouse will work normally, but inking will not be available. The screen resolution with the VGAP.DRV screen driver is limited to 640x480 (standard VGA resolution). This is the normal resolution of laptop computer displays; however many desktop computer use higher resolutions.

1 Copy the files PENWIN.DLL and VGAP.DRV to the \WINDOWS\SYSTEM Directory

2 Edit the SYSTEM.INI File (in the \WINDOWS Directory) as follows:

In the [boot] section:

Add "penwindows" to the list of drivers in the "drivers=" statement, for example, "drivers=mmsystem.dll penwindows"

Comment out (place a semicolon in front of) the existing "display.drv=" statement, and replace it with the statement "display.drv=vgap.drv"

In the [Drivers] section:

Add a new statement
"penwindows=C:\WINDOWS\SYSTEM\PENWIN.DLL"

3 If a higher-resolution display is desired on a desktop computer, skip the installation of the VGAP.DRV driver. Windows Write will not function in this configuration, but the MPIU program will run at the normal screen resolution.

For an More Complete Installation:

The MPIU program will run and mouse inking will be available, but cursor control with the mouse will be degraded.

1 Copy PENWIN.DLL, MARS.DLL, MARS.MOB, VGAP.DRV, MSMOUSE.DRV, and YESMOUSE.DRV to the \WINDOWS\SYSTEM Directory

2 Copy PENWIN.INI to the \WINDOWS Directory

3 Edit the SYSTEM.INI File as follows:

In the [boot] section:

Add "pen penwindows" to the list of drivers in the "drivers=" statement, for example, "drivers=mmsystem.dll pen penwindows"

Change the "display.drv=" statement to:
"display.drv=c:\windows\system\vgap.drv"

Change the "mouse.drv=" statement to:
"mouse.drv=c:\windows\system\yesmouse.drv"

In the [Drivers] section:

Add a new statement:
"penwindows=C:\WINDOWS\SYSTEM\PENWIN.DLL"

Add a new statement:
"pen=c:\windows\system\msmouse.drv"

4 Check (and edit if necessary) PENWIN.INI to ensure that the paths to MARS.MOB and MARS.DLL are correct (These files are in C:\WINDOWS\SYSTEM).

For Both Types of Installation

The MPIU program was written in the Microsoft Visual Basic Professional v.3.0 Development Environment. The Visual Basic run-time package and several library and custom control files are needed for the program to run. These are:

VBRUN300.DLL
PENCNTRL.VBX
GRID.VBX
THREED.VBX
CMDIALOG.VBX
MSOUTLIN.VBX

These files should be copied to the **\WINDOWS\SYSTEM** directory of the target computer. It is the responsibility of the user to ensure that the most recent versions of these files available are used. If more recent versions of the same files already exist on the target machine, use them, don't overwrite them.

Installing the MPIU Programs

1 Create directories C:\TANKSHIP and C:\BARGE

2 Copy the Files TANK.EXE, FIELDS.TXT, FORMS.TXT, FORM2.TXT, TOC.TXT, CLASSSOC.TXT, FLAG.TXT, and REPORT.TXT to the TANKSHIP directory from the same directory on another computer.

3 Copy BARGE.EXE and the same files named above to the BARGE directory. Please note that the FIELDS.TXT, FORMS.TXT, FORM2.TXT, TOC.DAT, and REPORT.TXT are not the same files for the Tankship and Barge Programs, although they have the same names. Be very careful keeping these straight.

4 When the program runs for the first time, two files named DB.DAT and FORM2.DAT are created, which replace FIELDS.TXT, FORMS.TXT, and FORM2.TXT. Thus copying DB.DAT and FORM2.DAT (both different for Tanker and Barge programs, but similarly named) is an alternative to copying the files they replace.

File Locations and Editing

All of the Pen Extension and Visual Basic files mentioned above are supplied on a single floppy disk labelled "Pen Extensions". These files also exist in all three of the MPIU computers. The changes to **SYSTEM.INI** and **PENWIN.INI** can be made with Windows Notepad, which is a simple DOS Text (ASCII) file editor.

Copying of files can be done over an Interlink connection using File Manager or DOS, or can be done with floppy disks. In any case. be very careful to keep the like-named program and program support files in the TANKSHIP and BARGE directories and the like-named inspection data files in the various inspection directories separate.

USING THE SUPPORTING SOFTWARE

INTERLINK

Interlink is a component of the MS-DOS 6.0 (and later) operating systems which allows files to be transferred between two computers using a cable connection. The device driver INTERLNK.EXE is installed in the CONFIG.SYS file of the MPIU computers. When the command **INTERSVR** is executed on one computer (the server), its storage devices become available as additional drives to the other computer (the client). The server acts as a "slave" while the connection is active; the client computer takes control of both systems and works normally. Files can be transferred either from server to client or to client to server, all under the control of the client. For the MPIU project, we use a special parallel cable to make the connection.

Using Interlink and Windows File Manager, files or groups of files can be transferred quickly, efficiently, and reliably between computers, with no limits on file size. It is often easier to transfer files with an Interlink connection than with a floppy disk. Since the Dauphin DTR-1 has no floppy disk drive, Interlink is the only way to transfer files to and from it.

Using Interlink

To use Interlink:

1 Connect the parallel (printer) ports (DB-25 female) of the computers together with the yellow cable (DB-25 male-to-male) provided with the MPIU system. (These cables are sold in computer stores as "LapLink" or "DOS 6-LapLink" cables).

2 The server computer must have a keyboard attached. Since files can be transferred easily in both directions, either computer can be the server.

3 On the "server" computer, from Windows, select "File - Run", then type (or print with the pen) the command "INTERSVR". The Interlink screen should appear, stating that a connection has been made over the parallel port.

4 On the client machine, open File Manager. The drives of the server should be available as additional drive letters, (beyond A, B, and C). Once an attempt is made to read a server drive from the client, the Interlink screen on the server should show the connection being made and show the client drive letters which are assigned to the server drives.

If the connection is not successful, drives beyond C: will not be accessible on the client computer, and the Interlink screen on the server computer will not show that a connection has been made. If Interlink fails to make a connection, one or both of the machines may need to be rebooted. (The power-saving "sleep" modes of battery powered computers sometimes disable or alter the state of the printer ports, requiring a reboot to reactivate them). First reboot the server computer (Windows will restart automatically), then issue the INTERSVR command again. If the connection still doesn't work, reboot the client and go back to File Manager.

Once the connection has been made, File Manager can be used to transfer files between drives as if they were all connected to the same computer. One disadvantage of using a pen-computer (without its keyboard) as an Interlink client is that selection of multiple files in File Manager is not as easy because the Shift and Control Keys are not available. These keys, in combination with the mouse (or the pen) give added flexibility to the selection of groups of files in File Manager.

Interlink Help

Help for Interlink is available from the MS-DOS command line (not accessible to pen-computers without their keyboards) by typing "HELP INTERLNK". As with many components of MS-DOS 6.0 and 6.2, there is no written documentation for Interlink.

FOTOMAN

FotoMan is the Logitech Digital Camera support program. It is available from the MPIU group in Program Manager. With the camera in its docking/charging station, FotoTouch connects with the camera when it starts, and allows selection of the pictures to be downloaded from small "postage-stamp" images. Up to 32 images can be stored in the camera at one time.

The selected images are named sequentially, with a file prefix provided by the user. The photographs should be saved in bitmap (.BMP) format in the proper inspection directory for the ship they apply to.

The user is prompted for the file prefix, which will be used for all the files in a given group. The 8-character filename will be the prefix plus sequential numbers, and the file extension should be .BMP. (Example - ASHIP001.BMP, ASHIP002.BMP, etc.). The number of characters in the file prefix is up to the user, but you should leave room for enough digits to prevent ambiguous names - 5 characters will allow 3 digits, which should prevent any problems with identification.

ZYINDEX and ZYFIND

ZYIndex is a commercial Windows program for indexing and searching text files. Parts of Titles 33 and 46 of the Code of Federal Regulations (33CFR and 46CFR) which apply to tankship and barge inspections have been included as files on the hard disks of the Compaq Concerto pen/laptop and IBM ThinkPad 300 laptop computers. Indexes have been created using ZYIndex to allow the ZYFind module of ZYIndex to conduct searches of this reference material. The ZYFind module is loaded onto the Compaq Concerto pen/laptop computer and the IBM Thinkpad laptop computer, but it is not on the Dauphin DTR-1 pen computer, due to hard disk space limitations.

The Code of Federal Regulations is organized by "Titles", "Subchapters", "Parts", and "Sections". Each applicable Part is stored on disk as a separate file. The filenames indicate the Title, Subchapter, and Part. For example, the file which contains Part 34 (Firefighting Equipment) of Subchapter D (Tank Vessels) of Title 46 (Shipping) is named "46D34". These files contain the entire text, but not the illustrations, of the Part indicated. Additional files for each Subchapter contain the Outlines and Tables of Contents (TOCs) for each Subchapter (for example "46Dcont") and also the CFR indexes for those Subchapters which have them (for example "46Dindx").

While it is anticipated that inspectors will refer to the CFR primarily during the writing of the inspection report, ZYIndex can be used concurrently with an MPIU program on the IBM laptop and on the Compaq pen/laptop. Using the facilities of Windows, both an MPIU program and ZYIndex (and other applications as well) can run simultaneously. A user could, for example, switch from a running MPIU program to ZYIndex, conduct a search, paste a selected section of CFR text to a wordprocessing document in Windows Write, (or print it), and then return to the MPIU program.

Using the ZYFind Component of ZYIndex

An independent index has been created for each Subchapter. Each of these subchapter indexes provides access to a number of files, one for each Part in that Subchapter, along with additional files containing the Subchapter Outline and Table of Contents, and the CFR index for that Subchapter, if one exists. Indexes have descriptive names containing the Title, Subchapter, and a short version of the subchapter title, such as "46CFR D Tank Vessels".

The ZYFind module of ZYIndex is started from its icon in the MPIU group in Windows Program Manager. The program opens with the Search Window displayed. A list of selected indexes (Subchapters) is available in the "Search Aids

belong to:" box. These indexes are those which were selected when ZYFind was last run.

To modify the list of indexes to be searched, tap the command sequence: "Find; Select Index" starting from the main menu of ZYFind. (If there is an active Search Statement, it must be closed "discarded" before changing the index selection.) Indexes are selected by clicking them with the mouse or by tapping them with the pen. Selected indexes are highlighted. Clicking or tapping a selected index removes the highlighting and unselects it. Up to 5 indexes can be selected simultaneously. (ZYFind indicates that up to 8 can be selected - however, selecting more than 5 will cause ZYFind to crash. Luckily, ZYFind crashes in an orderly fashion, allowing the user to return to Windows and not affecting other programs which are running.) Avoid using the **ADD** and **REMOVE** buttons - these are used for adding indexes to or removing them from the list from which they are selected - all of the available indexes should already be shown and there should be no need to make any changes.

Once the indexes have been selected in the Select Index Window, the **OK** button brings up the Search Window. The Search Statement is entered into the text box either by keyboard or pen input, and the **SEARCH** button starts the search. When the search is complete, the Search Results Window is displayed, listing each individual file belonging to any of the selected indexes in which "hits", or matches to the search statement, were found, and how many hits were found in each file. Selecting and double-clicking one of the files brings up the File Display Window, which shows the actual text of the selected Part of the CFR. The cursor is initially at the beginning of the file, allowing the user to confirm the file's contents. Clicking or tapping the **HIT >** button allows the user to jump forward through the file from one hit to the the next hit. This button remains active as long as their are more hits. The **< HIT** button becomes active after the second hit is reached, allowing the user to jump backward from to the previous hit. The **FILE >** and **< FILE** buttons allow the user to jump directly from file to file in the order in which the files were listed in the Search Results Window.

Once a search has been completed in the File Display Window, the user can return to the Search Window by clicking or tapping the **SEARCH** button or to the Search Results Window by clicking or tapping the **RESULTS** button.

Entering the Search Statement

The success and thoroughness of a search depends upon the proper, and in some cases ingenious, entry of the search statement. By default, searches are not case-sensitive, so the user needn't be concerned about upper and lower case letters. The ZYIndex manual, ZYFind's built-in help and the Reference Option of the Help SubWindow of the Search Window give guidance on

entering search strings to get the desired results. A few of the basic techniques and special search characters are summarized below.

1 The asterisk "*" is a "wild-card" character, which can take the place of any number of letters, including none. For example, "valve*" will find valve, valves, valve-wheels, and any other word beginning with "valve". "firemain valve*" will find both "firemain valve" and "firemain valves".

2 The OR and AND functions enable Boolean searches. For example, "Fire OR Safety" will lead (in the Search Results Window) to every file which is covered by one of the selected indexes in which either one or both of those words occurs, and then, in the Text Window, to the words themselves. "Fire AND Safety" will lead only to files from the selected indexes in which both words occur, even if they do not occur in close proximity to one another.

3 More specific than AND and OR are the p/ and w/ functions, which denote "preceded by" and "within". For example, "quick-closing p/5 valve*" will find all cases in which "quick-closing" or "quickclosing" precedes "valve" or "valves" by 5 words or fewer. This search statement would find "quick-closing LNG system valves", for example. The search string "quick-closing w/5 valve*" will find all occurrences of "quick-closing" or "quickclosing" within 5 words of "valve" or "valves". This search would find everything which the previous one would, and in addition, would find strings such as "valves which are quick-closing", which the previous example would not.

4 Hyphens are ignored by the search routine, so "quick-closing" and "quickclosing" get the same results; neither will find "quick closing". However, "quick*closing" will find "quickclosing", "quick-closing", and "quick closing".

The Use of Subchapter Tables of Contents and Indexes, and Section Headings

The Outline and Table of Contents for each Subchapter is contained in a separate file named, for example "46Dcont". For those Subchapters for which the CFR provides (not all have them), those CFR Subchapter indexes are contained in files named, for example, "46Dindx". The string "46D", for example, occurs only as the first line of the subchapter TOC and Subchapter Index files for Title 46 Subchapter D, so a search using the string "46D", for example, will lead only to the files "46Dcont" and "46Dindx" in the Search Results Window, and the File Display Window will lead directly, and only, to the beginning of the TOC and Subchapter Index files for 46CFR Subchapter D. Multiple subchapter TOCs and

indexes could easily be brought up in the Results Window simultaneously by searching on, for example, "46D OR 46J OR 46F"

Once the TOC or Subchapter Index files are opened in the File Display Window, the user can scroll through them freely. Information can also be extracted from those files for use in further searches of the text of the CFR itself; techniques for doing this are explained below.

Each section in the CFR has a section number unique to that Title, for example "32.15-5 Anchors, Chains, and Hawsers" in 46CFR Subchapter D (note, however, that ther may also be a section 32.15-5 in Title 33). Two additional indexes have been created, one covering all of the included Parts of 33CFR and one covering all of included Parts of 46CFR, each indexing only numbers, periods, and hyphens (hyphens are treated as real characters in these two indexes only). These indexes, titled "33CFR Headings", and "46CFR Headings" respectively, can be used with Subchapter Tables of Contents and Indexes to jump to the text of sections found by scanning the Subchapter TOC's or indexes.

In many cases, the user may want to find a subject, rather than a keyword. The following example shows how the headings index can be used to provide access to a section of Title 46:

1 Select "46CFR Headings" and one or more subchapters of Title 46 in the "Find; Select Index Window. Click **OK** to go to the Search Window.

2 Type a search statement such as "46D OR 46J" and search for it. Since these words occur only at the beginning of the files "46Dcont","46Dindx", "46Jcont", and "46Jindx", those files will be listed in the Search Results Window.

3 Double-click on the desired file - the Text Window will open with the cursor at the beginning of the file.

4 Scroll through the file or jump to one of the other files as desired.

5 To see the text of a particular section, highlight the number of the section with the pen or the mouse and copy it to the Windows Clipboard with the "Edit; Copy" command from the top menu. Now switch to the Search Window, place the cursor in the Search String Textbox, and select "Edit; Paste" from the top menu. The section number which was extracted from the TOC or index now appears in the search box. Press "Home" to move the cursor to the beginning of the string (or tap or click there) and inset a double quote (") at the beginning of the numerical string. Click the **SEARCH** button.

If the search string was, for example, " "32.60-30 " from Subchapter D of Title 46, the Results Window will show several files, one of which will be "46D32". "46Dcont" and "46Dindx" will also be shown, since the section number appears in both of these files. There may be others. Double-clicking on "46D32" will lead first to the beginning of the file, then selecting **HIT** will lead eventually to the text of section 32.60-30.

Other hits in 46D32 and hits in files other than 46D32 may also be of interest. These are citations of 46D 32.60-30 from other locations in the selected set of indexes. For example, if 46D 32.60-30 was a specification for a particular type of fire hose nozzle, the other hits would most likely be requirements that hose nozzles in certain situations meet this specification. The other hits may occur in 46D Part 32, in other Parts of Subchapter D, or in other Subchapters whose indexes are selected for searching.

Extracting Text

Sections of text can be extracted from the CFR for inclusion in other documents or for printing. Using the pen or mouse, select (highlight) any desired material, then copy it to the Windows Clipboard, from where it can be pasted into another application, such as a Windows Write word-processing document. Highlighted blocks of text can be printed directly from ZYFind using the "File; Print" command sequence, or they can be pasted into a Windows Write document (running concurrently with ZYFind) for combination with other citations, then edited and printed later from Write or Notepad.

Notes and Troubleshooting

The files indexed and accessed by ZYFind can not be altered, even inadvertently, when they appear in the Text Window. The only editing operation available in the Text Window is copying selected information to the Windows Clipboard.

If ZYFind crashes due to selection of too many indexes in the "Find; Select Index" menu, follow the "OK" buttons back to File Manager. ZYFind can then be started again; the first action after a restart should be to reselect the indexes to ensure that no more than 5 are not selected.

In order for ZYFind to recognize text and gesture entry from the pen, the Pen Palette must be running. This is installed in the Startup Group in Windows and should always run initially in minimized form. If text and gesture recognition fail to work in ZYFind, check to see if the Pen Palette program has been inadvertently closed. If it has, start it again and minimize it. (The Pen Palette is located in the Accessories Group). The mouse functions of the pen do not require the Pen Palette, nor do fully "pen-aware" applications like the MPIU program.

WINDOWS WRITE

Write is an integral support program of Windows. It is a basic wordprocessing program, and it is the wordprocessing program of the MPIU system. It's operation is simple enough that a user familiar with the basic principles of Windows should be able to use it without referring to any written instructions. An on-line Windows help file is available, and written documentation for Write is contained in Windows 3.1 manuals. Write supports Clipboard transfer of text and graphics to and from other Windows applications.

FIELDNOTES

Fieldnotes is a very sophisticated graphical program. Its capabilities include viewing and annotating engineering drawings, spacially oriented database operations, and support for geographical information systems (GIS). The extensive manual from the vendor is supplied with the MPIU system. Users are invited to experiment with Fieldnotes as an introduction to some of the graphical capabilities of portable computers.

CFR SEARCH PROGRAM

The CounterPoint Publishing CFR search program is located on, and executed from the CounterPoint CFR CD-ROM disk. It provides hierarchical searching capabilities to the CFR with ZYFind does not, however, its keyword searching capabilities are more limited than those of ZYFind. Instructions for using this program are contained in the vendor's manual supplied with the MPIU system. It can be run from the DOS command line or in a full-screen window from Windows.

ADDITIONAL DOCUMENTATION

In addition to this Users' Manual, a number of other pieces of written documentation are provided.

Dauphin DTR-1 (1 set)
- Owners' manual with supplement
- Battery charging instructions
- Quick-reference guide
- MS-DOS 6.0 manual
- Windows 3.1 manual

Compaq Concerto (1 set)
- DOS/Windows Manual
- PenWindows Manual
- Keyboard Reference (pamphlet)
- "Beyond Setup" (pamphlet)
- Pen Instruction sheet

IBM ThinkPad 300 (1 set)
- Guide to Operations (booklet)
- Features Guide (pamphlet)
- Installation and Setup Guide (pamphlet)

LogiTech FotoMan Digital Cameras (2 sets)
- Users' Guide (pamphlet)
- Installation Guide (brochure)

Microsolutions CD-ROM Drive (2 sets)
- Users' Manuals

HP DeskJet 310 Printer (2 sets)
- Quick Start (pamphlets)
- Users' Guides
- Windows Software Guides

Counterpoint CFR CD-ROM
- 1 CD-ROM disk
- Users' manual (1 looseleaf binder)

ZYIndex
- Users' Manual (1 spiral-bound book)

FieldNotes
Users' Manual (1 spiral-bound book)

HARDWARE INVENTORIES

Dauphin DTR-1 6/40 MB (1)
System Carrying Bag w/ shoulder strap
Computer Case
DTR-1 computer with slide-on cover, pen, and battery
Keyboard with Cord
Keyboard extension cord
2 Power supplies
Battery charger
Spare battery
Spare pen with extra tips

Compaq Concerto 8/120 MB (1)
System Carrying Bag w/ shoulder strap
Concerto Computer with pen and battery
Detachable keyboard
AC adapter with AC line cord
Charging adapter
Spare battery
Spare Pen with extra tips

IBM ThinkPad 300 8/120 MB (1)
System Carrying Bag with Shoulder Strap
Computer with Keyboard and Battery
Microsoft 2-button serial Mouse
AC adapter with AC line cord
Serial Port adapter

Logitech FotoMan I and FotoMan II digital cameras (1 each)
- Camera
- Carrying case
- Base station/charger unit
- AC Power supply
- Power cord
- Data cable
- Filter
- Lens adapter

HP DeskJet 310 Ink-Jet printers (2), each includes:
- Printer with Ink black ink cartridge
- System carring bag with shoulder strap
- Sheet Feeder
- AC adapter with AC line cord
- Printer Cable DB25 to Centronics

MicroSolutions Back-Pack CD-ROM Drives (2)
- CD-ROM with attached Parallel cable
- AC Power Supply

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APPENDIX A FIRST-LEVEL FORMS of the TANKSHIP PROGRAM

The opening screen and the nine first-level forms of the Tankship Program are presented in Figures 25-34. Each column on a First-Level Form represents an underlying Second-Level Form, and the captions in each column list the names of the Third-Level Forms and/or the Second-Level data entry categories for each of the Second-Level Forms. Therefore, the entire logical organization of the Tankship program is visible by viewing these nine Figures.

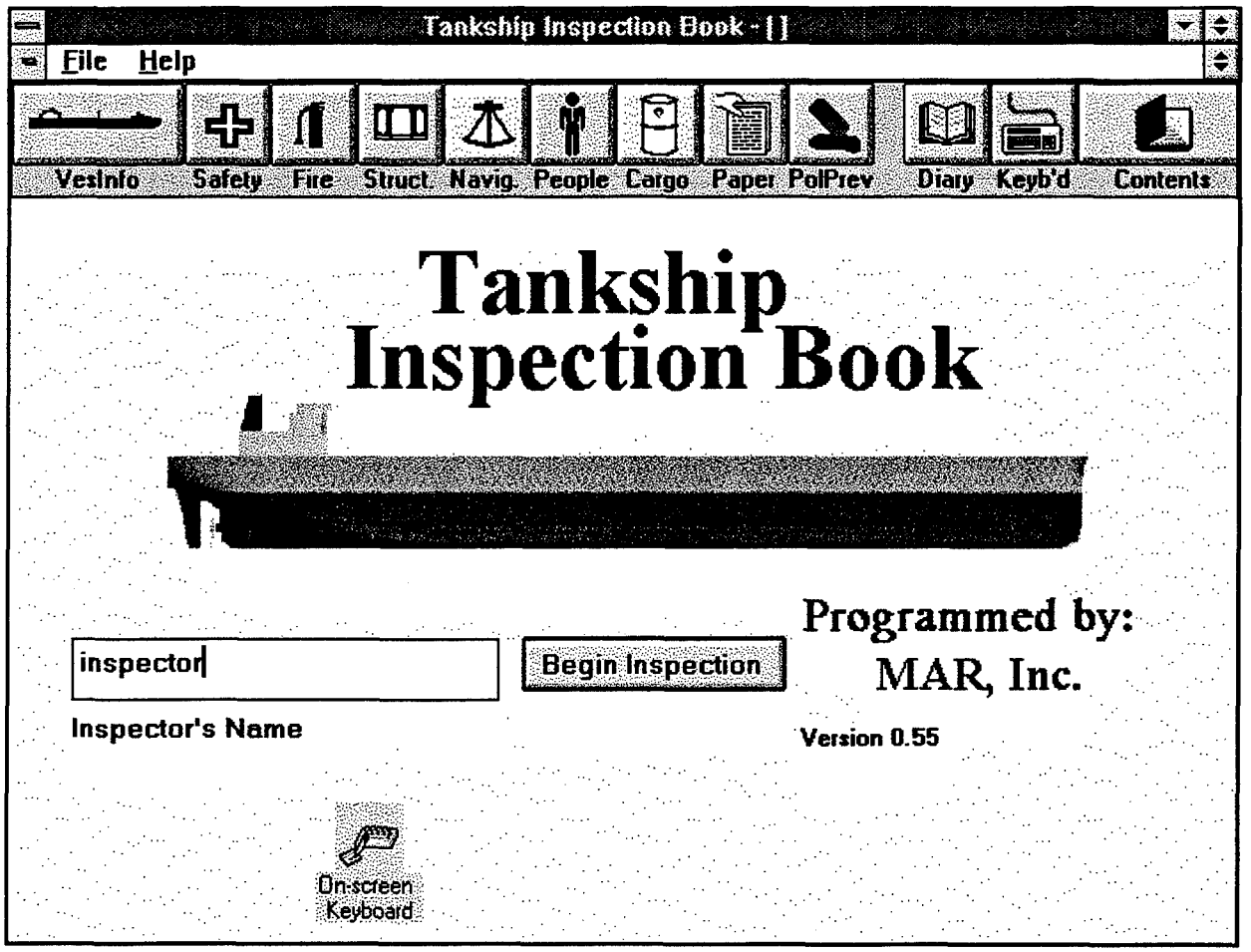


Figure 25 The Opening Screen of the Tankship Program

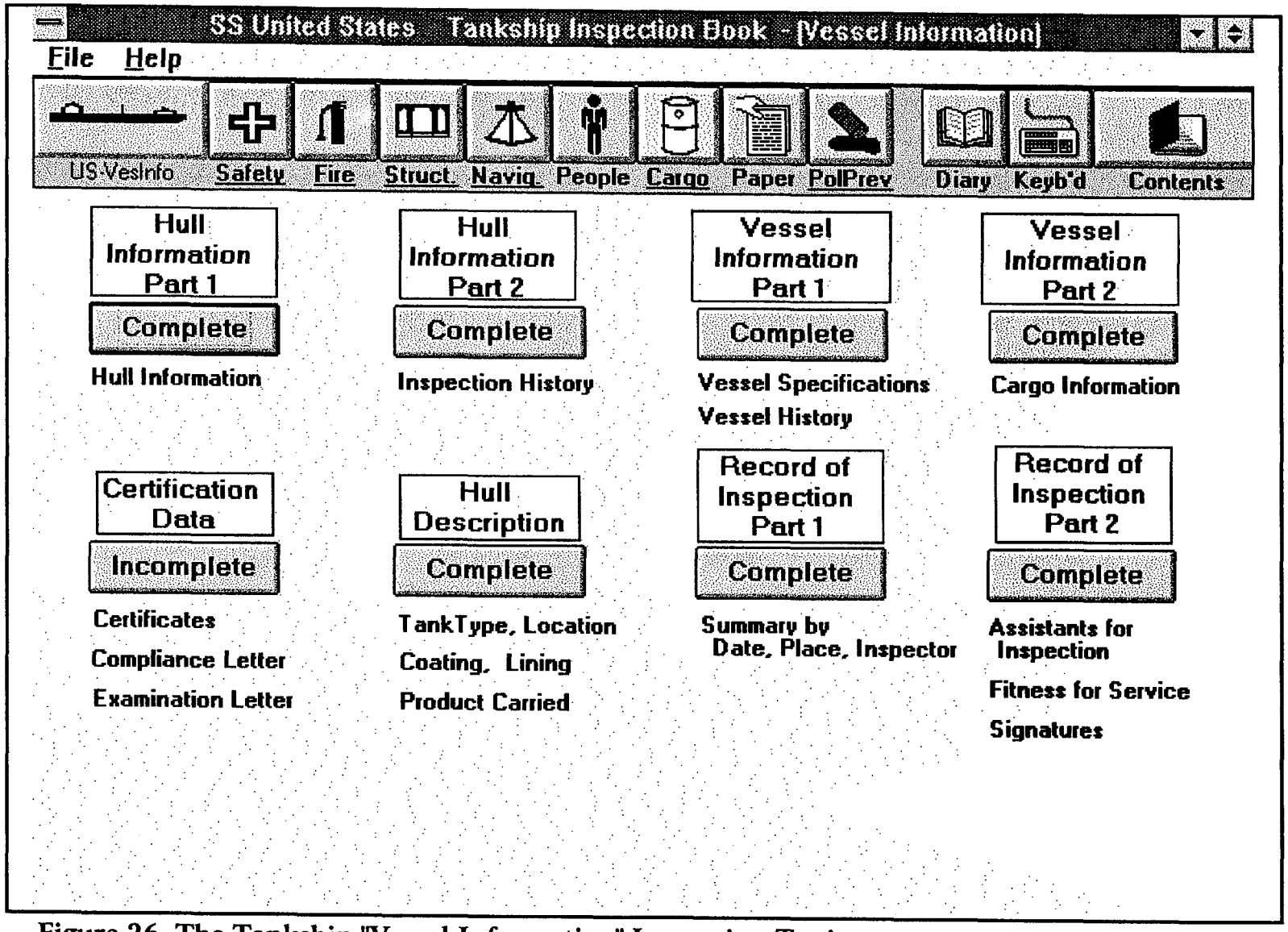


Figure 26 The Tankship "Vessel Information" Inspection Topic

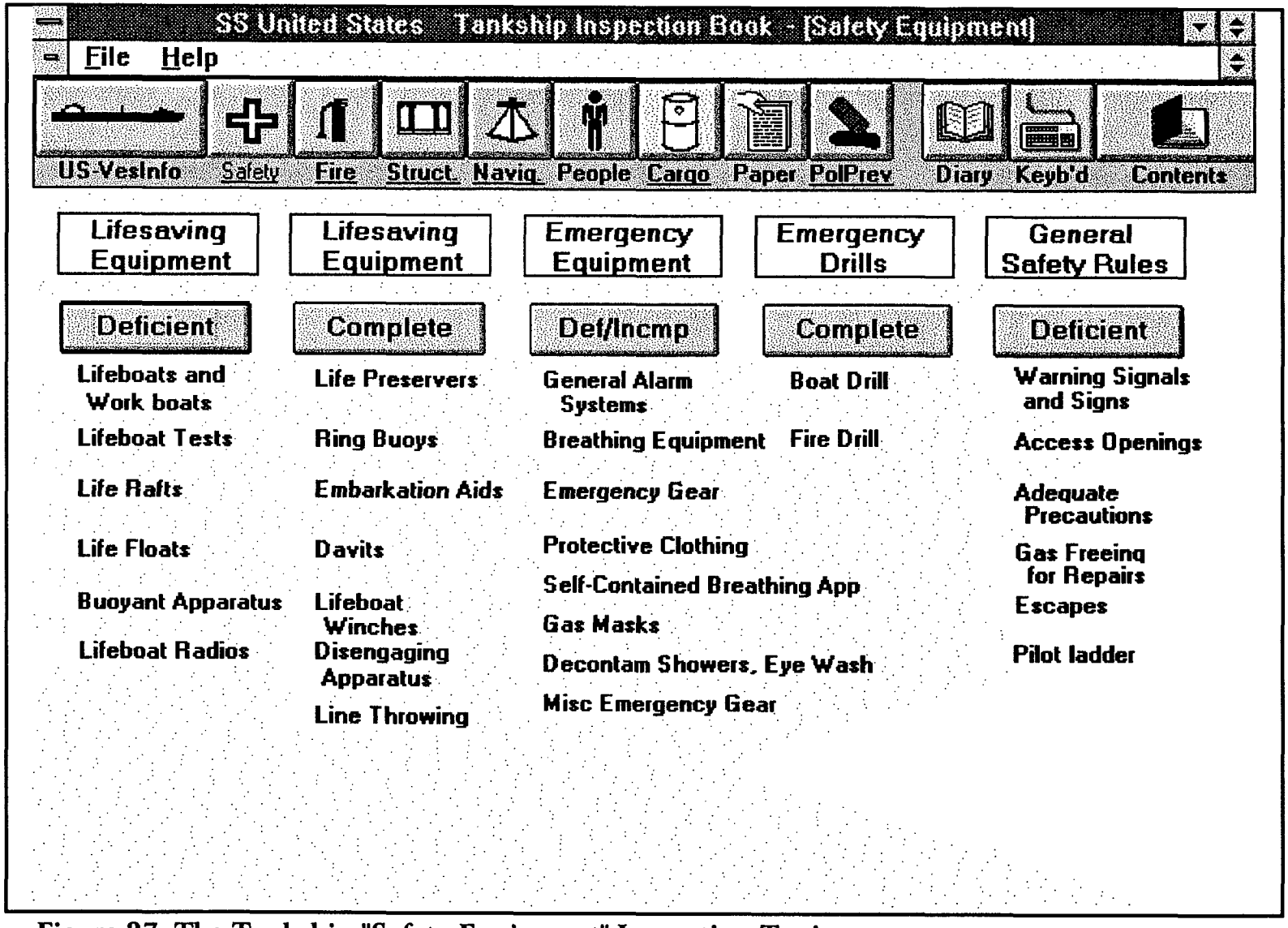


Figure 27 The Tankship "Safety Equipment" Inspection Topic

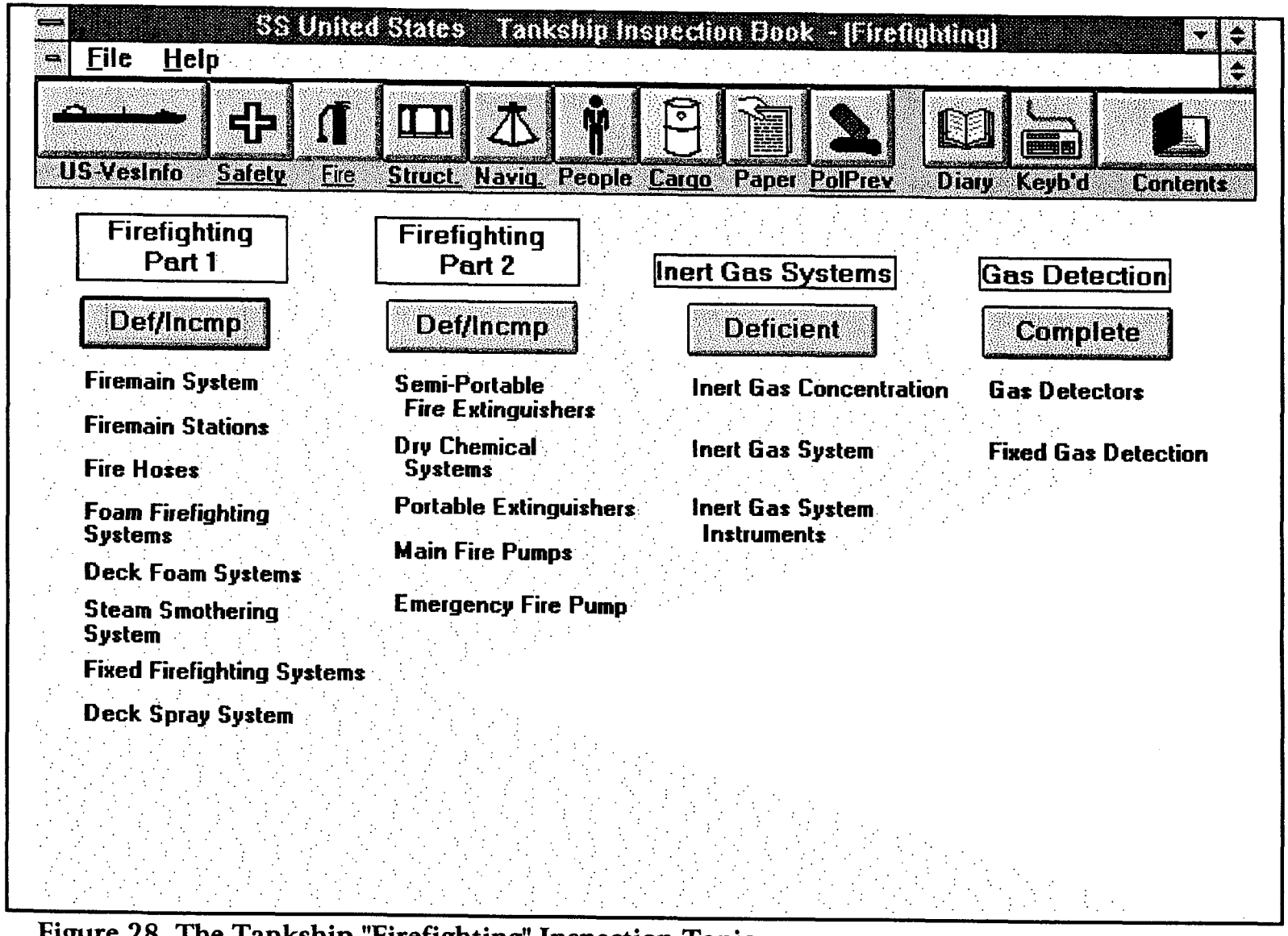


Figure 28 The Tankship "Firefighting" Inspection Topic

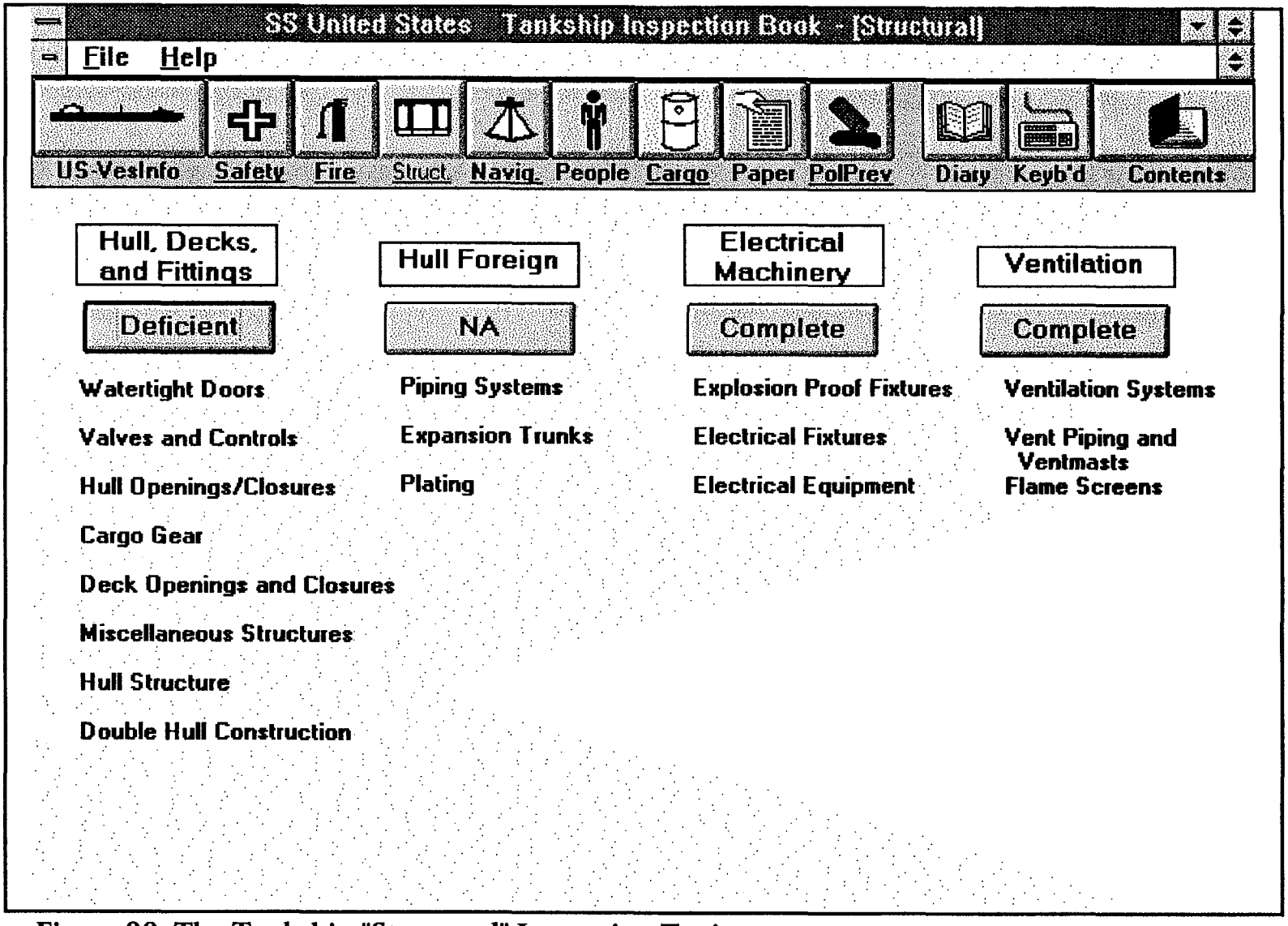


Figure 29 The Tankship "Structural" Inspection Topic

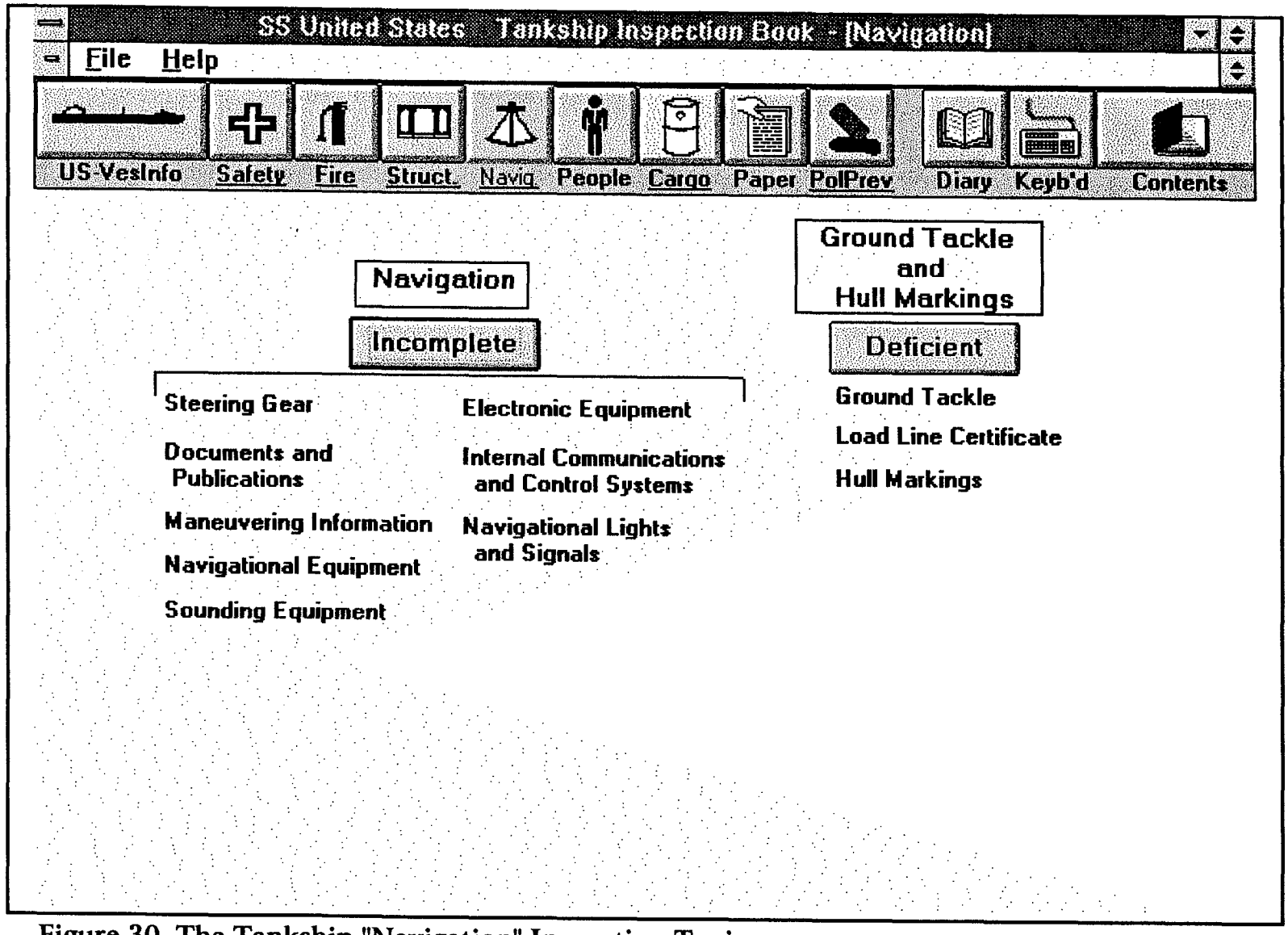


Figure 30 The Tankship "Navigation" Inspection Topic

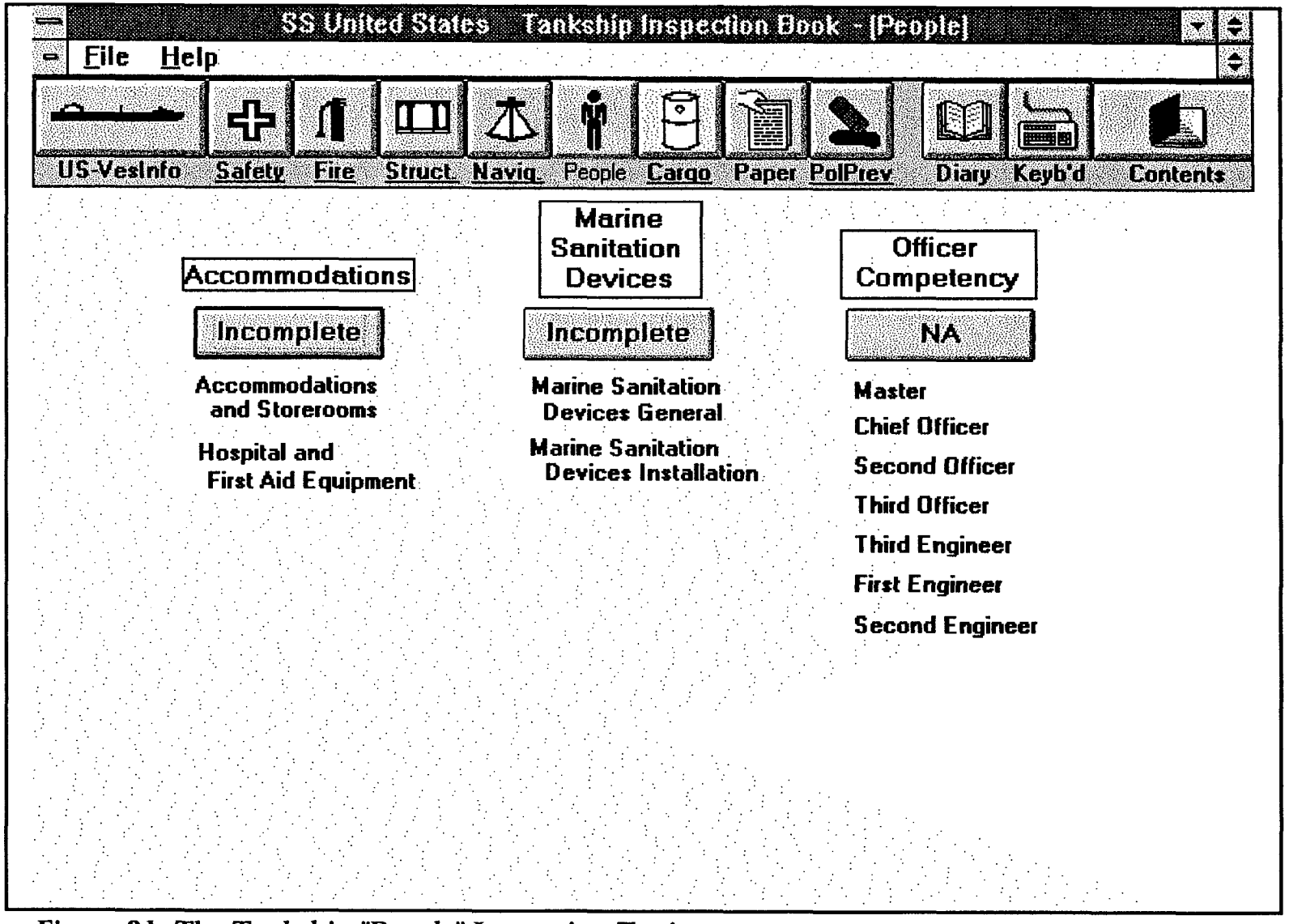


Figure 31 The Tankship "People" Inspection Topic

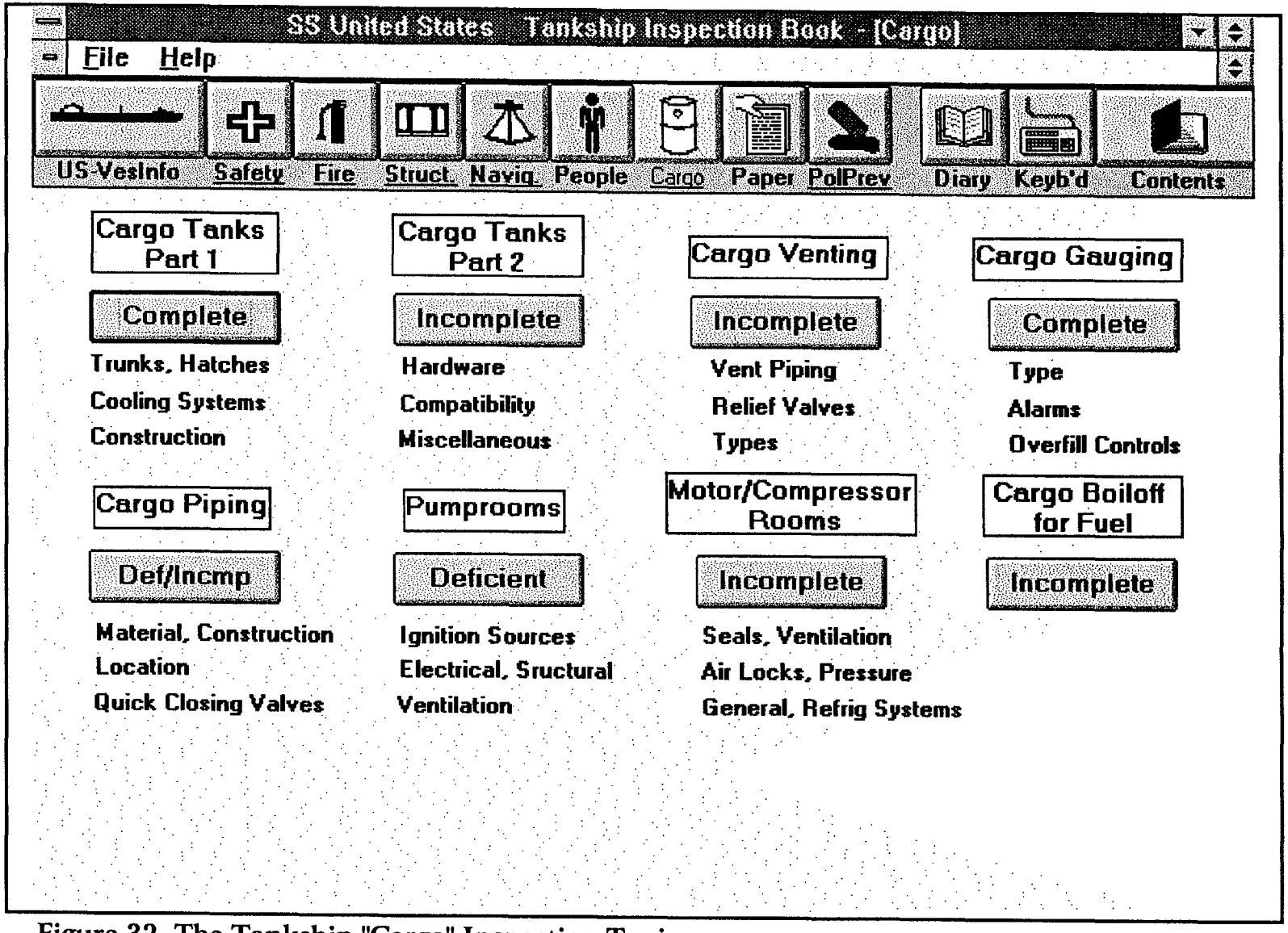


Figure 32 The Tankship "Cargo" Inspection Topic

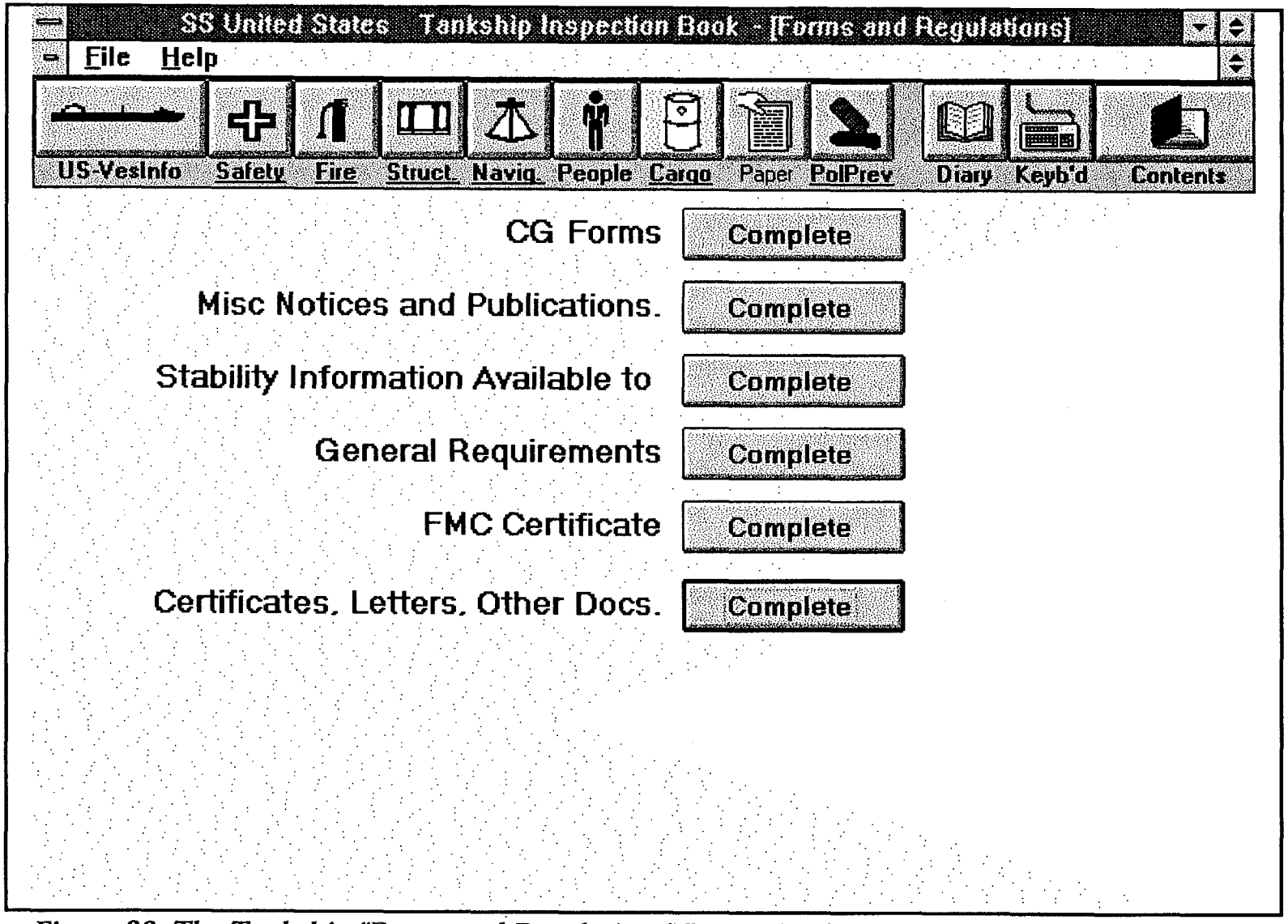


Figure 33 The Tankship "Forms and Regulations" Inspection Topic

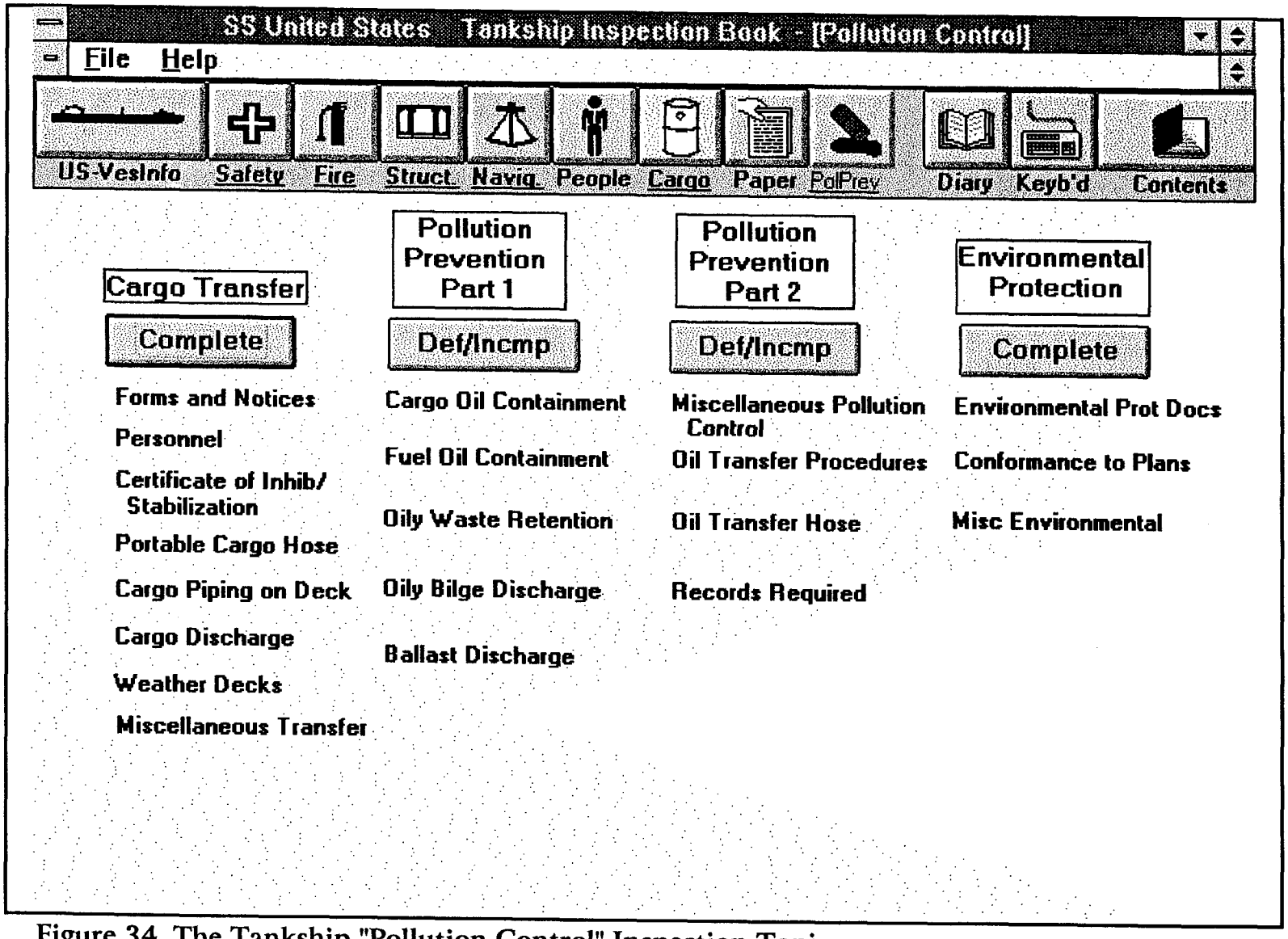


Figure 34 The Tankship "Pollution Control" Inspection Topic

APPENDIX B FIRST-LEVEL FORMS Of The BARGE PROGRAM

Figures 35-44 show the Opening Screen and the nine First-Level forms for the nine Inspection topics of the Barge Program. These forms show the entire logical organization of the Barge program.

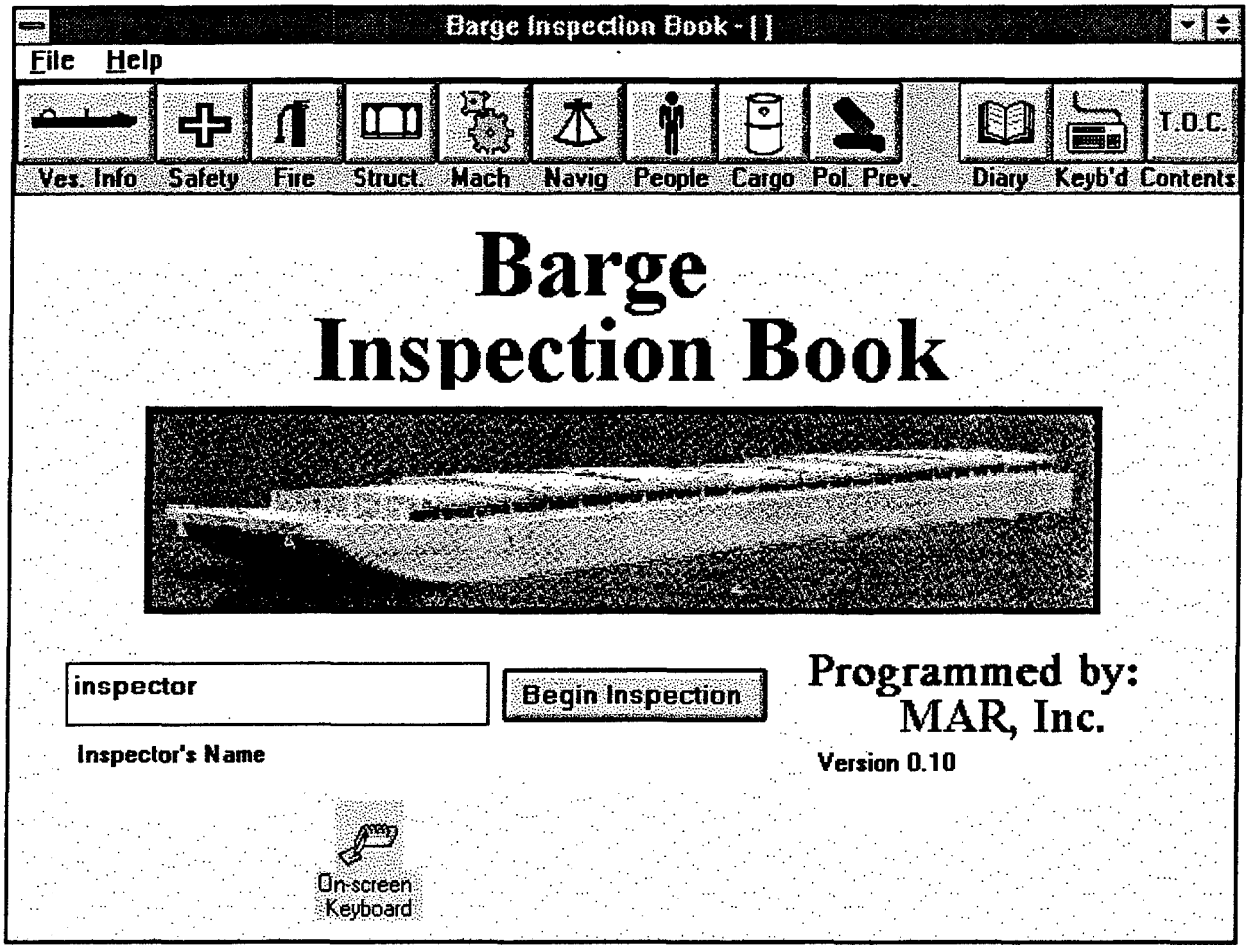


Figure 35 The Opening Screen of the Barge Inspection Program

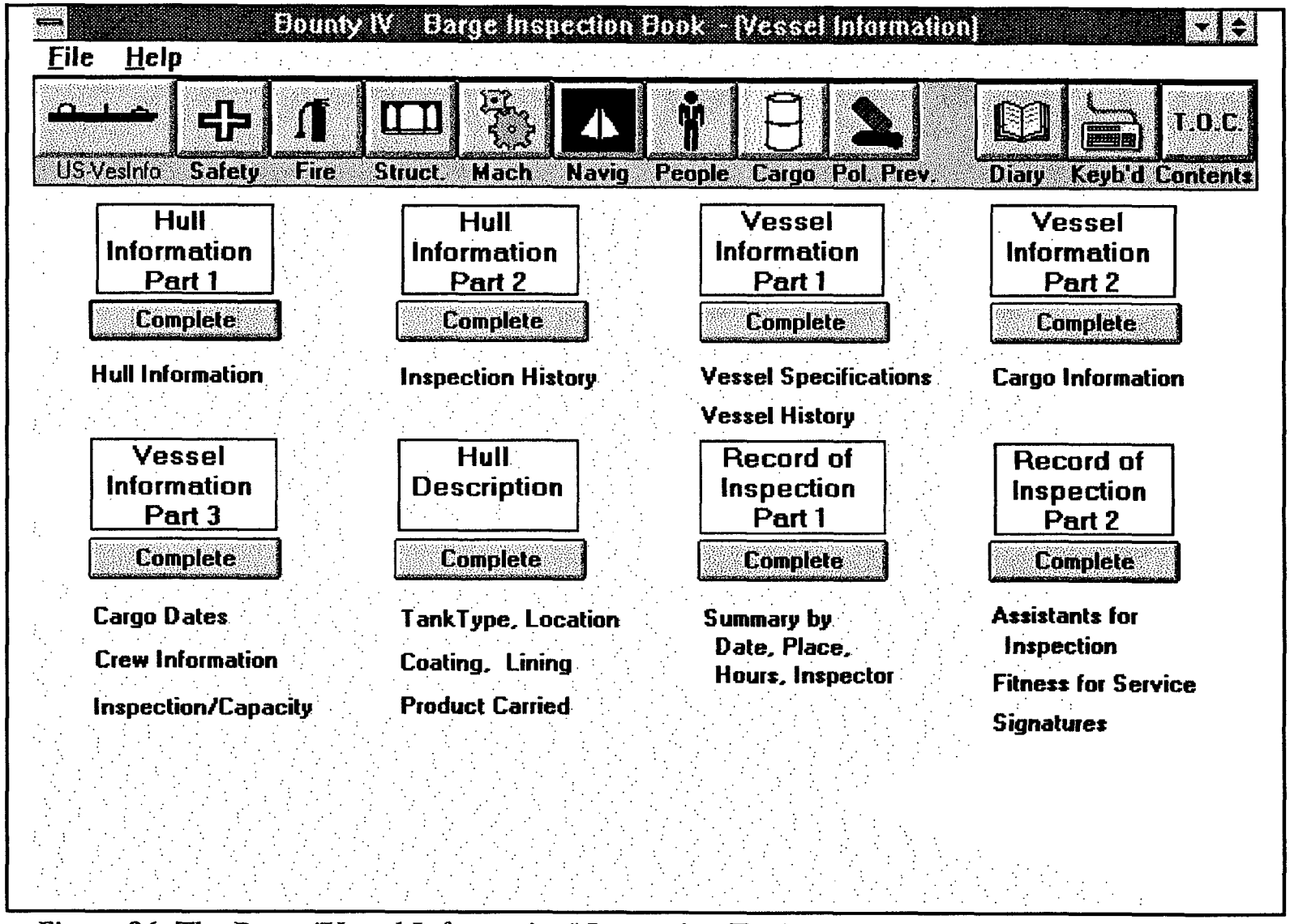


Figure 36 The Barge "Vessel Information" Inspection Topic

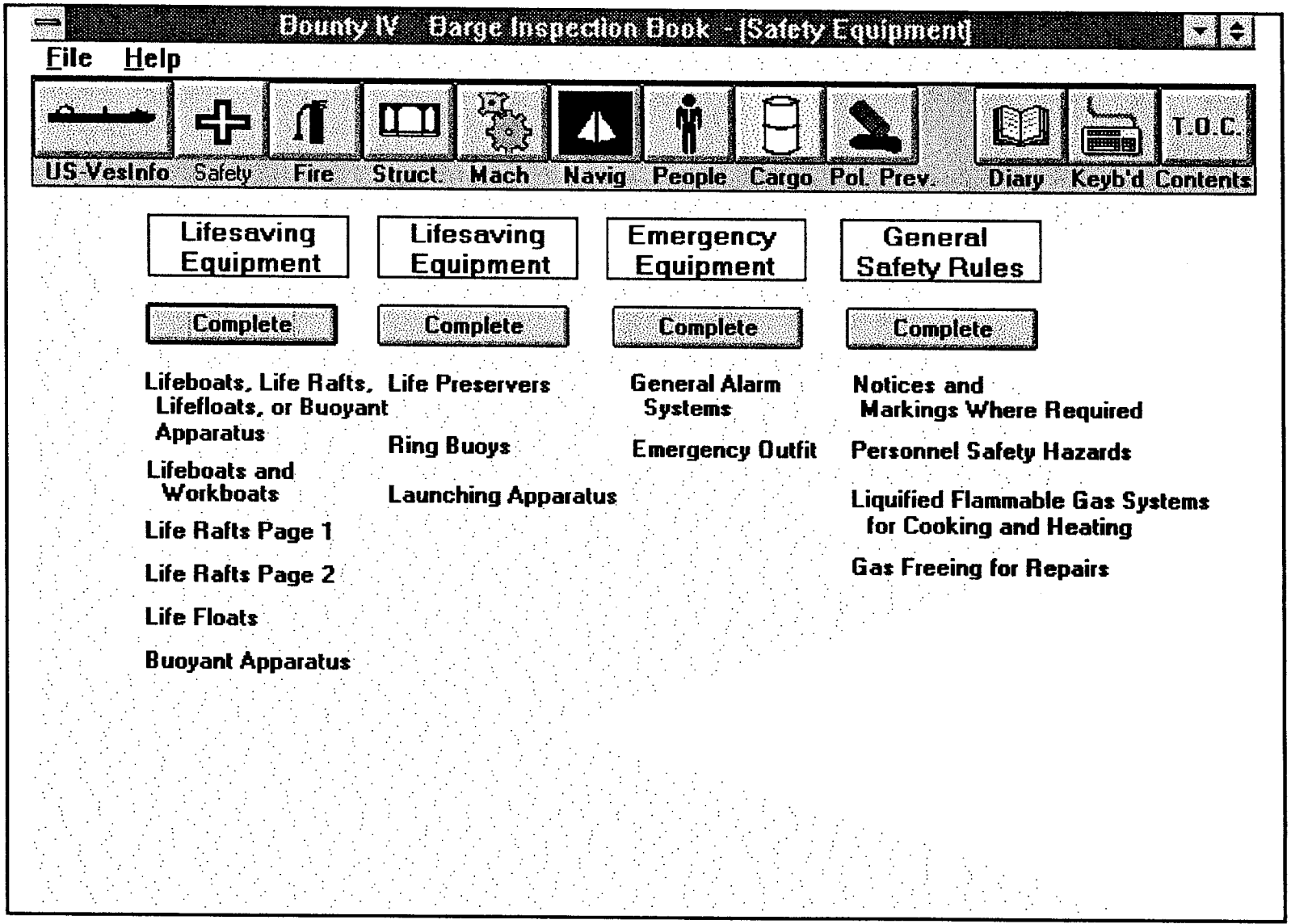


Figure 37 The Barge "Safety Equipment" Inspection Topic

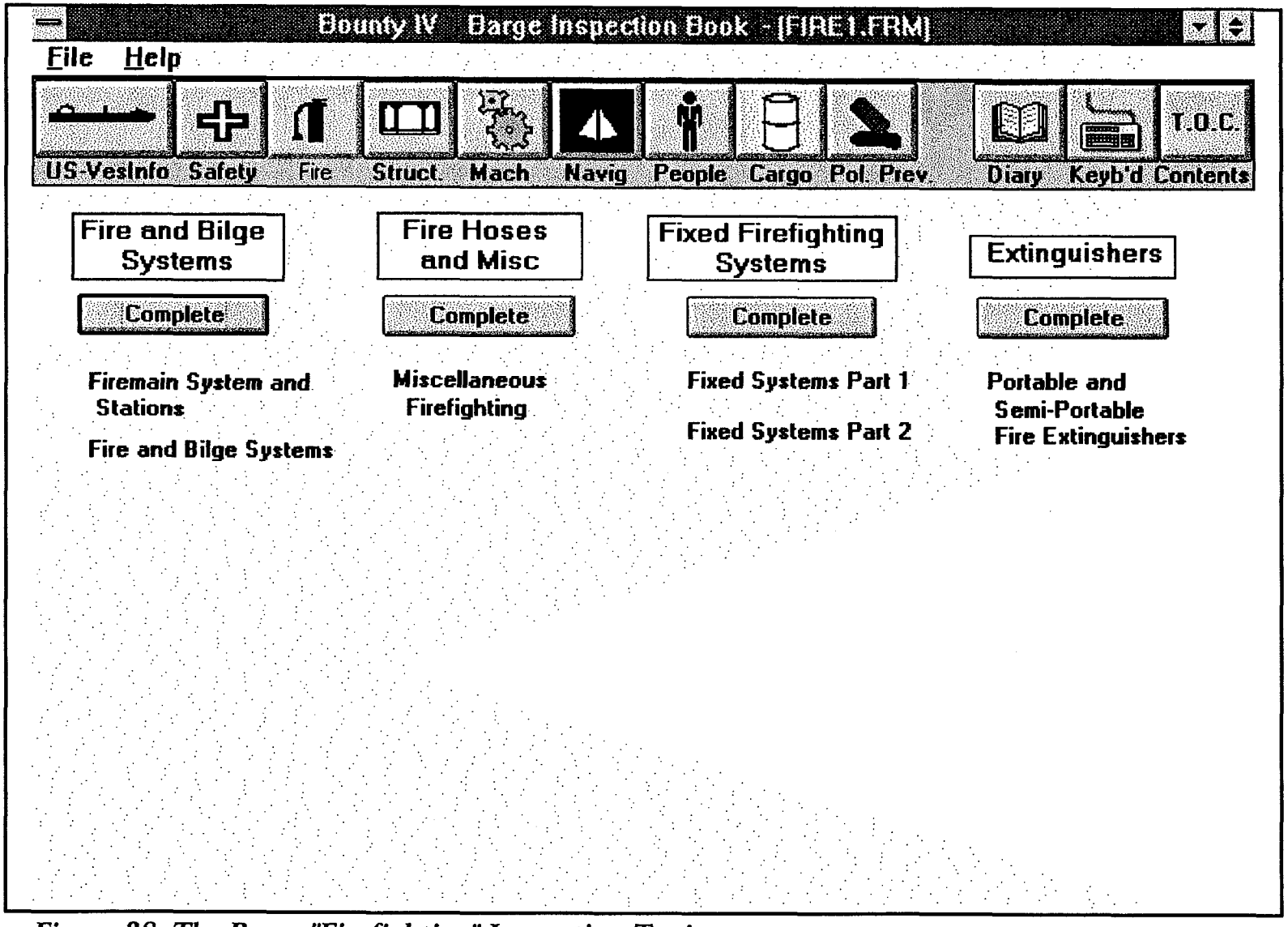


Figure 38 The Barge "Firefighting" Inspection Topic

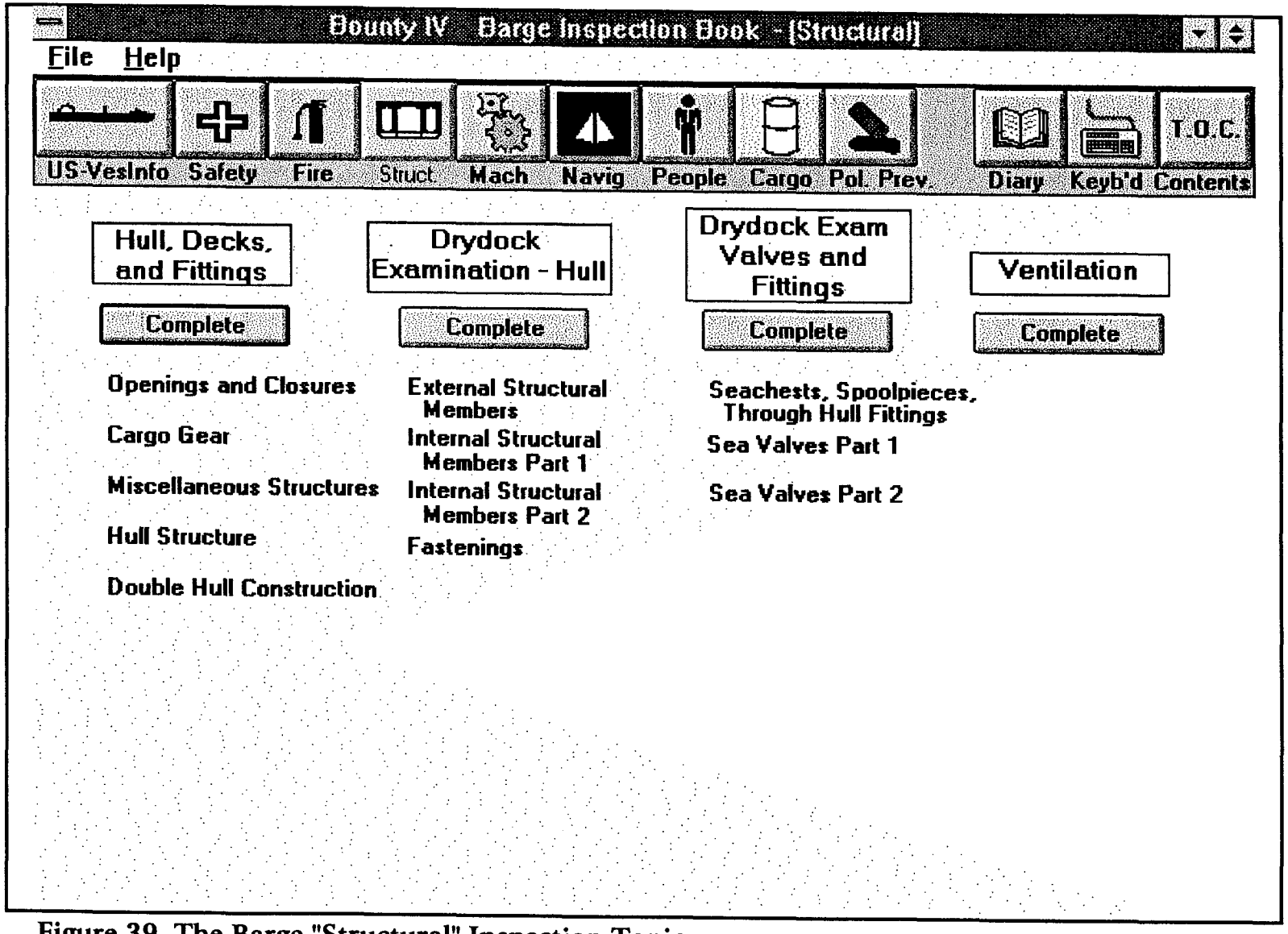


Figure 39 The Barge "Structural" Inspection Topic

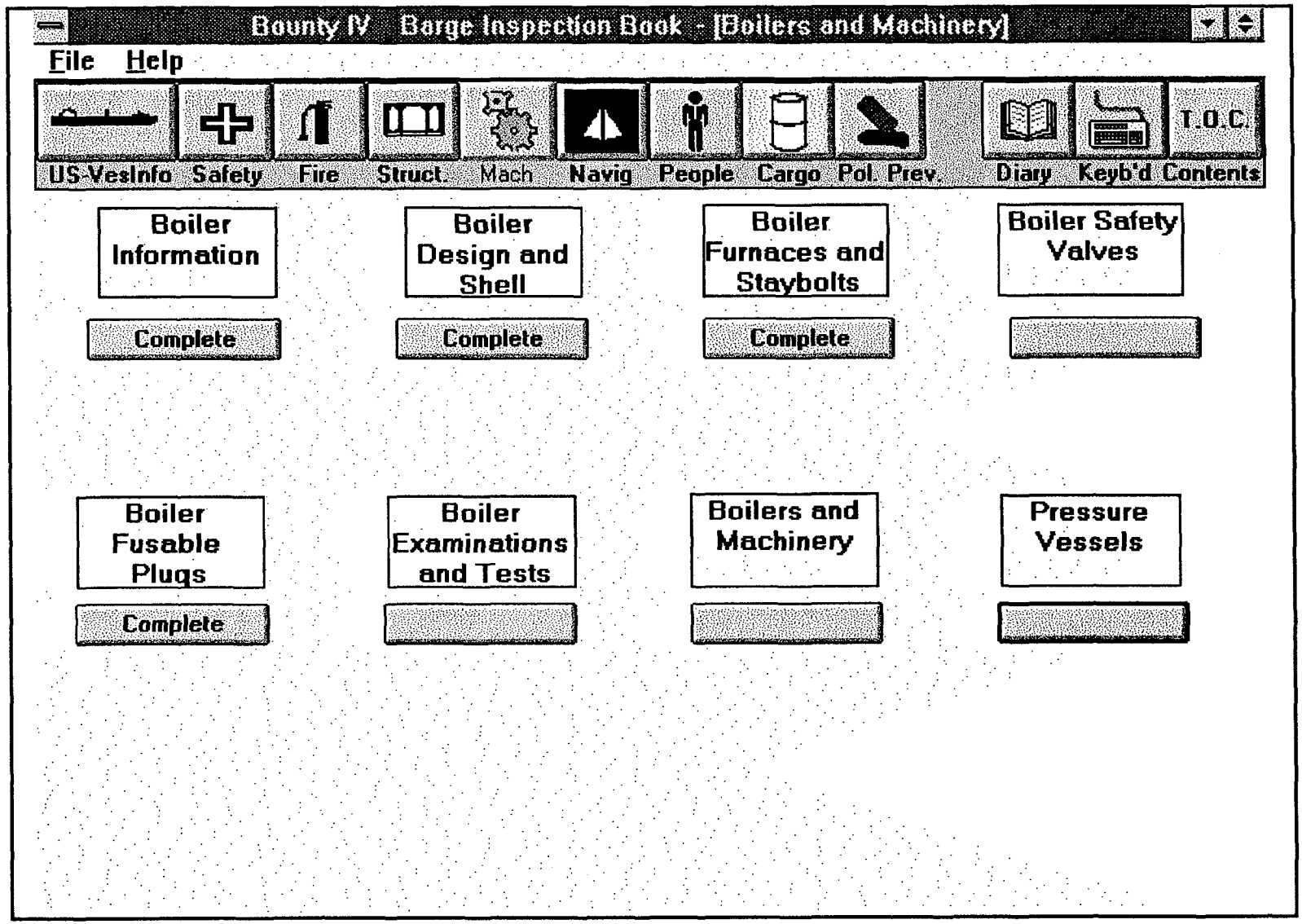


Figure 40 The Barge "Boilers and Machinery" Inspection Topic

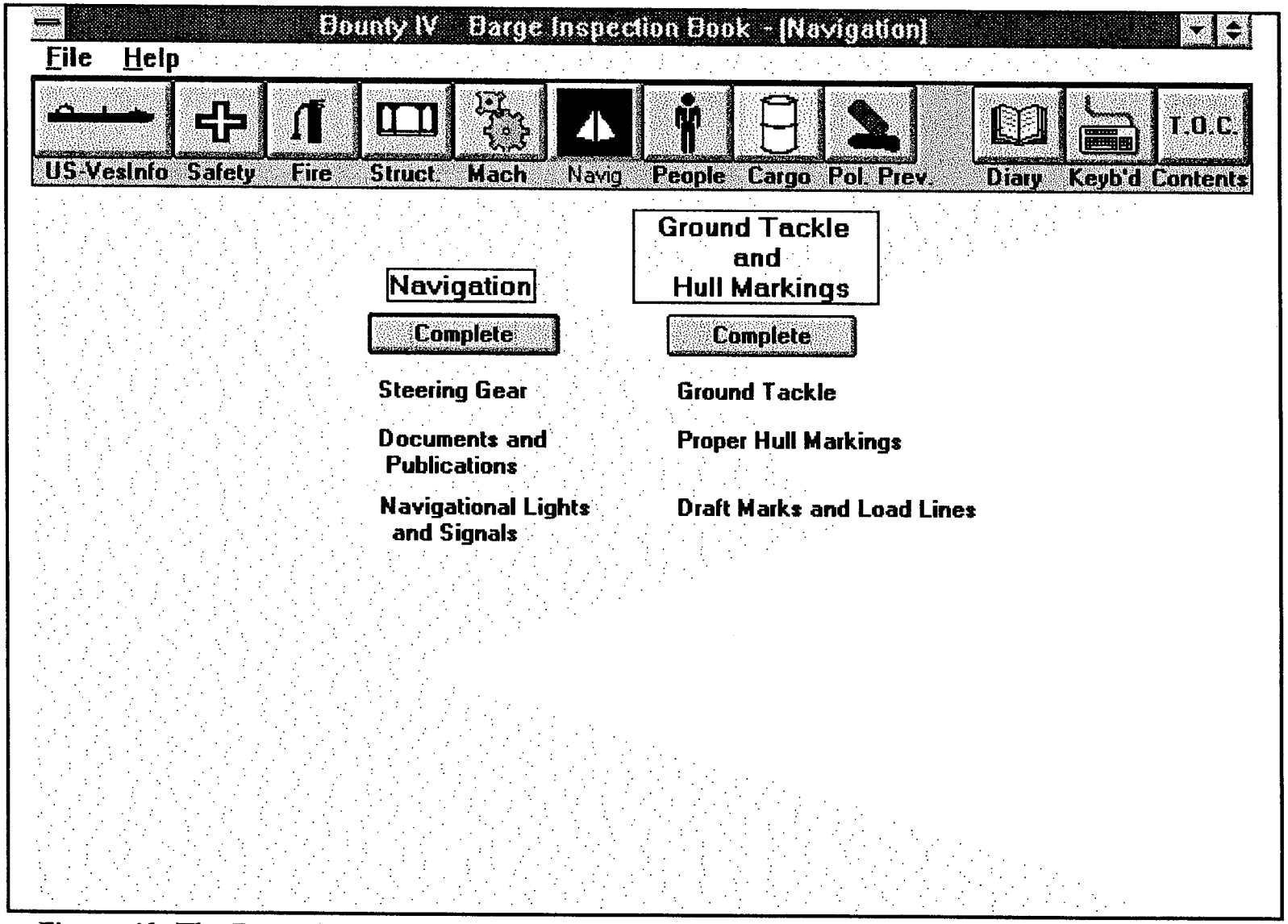


Figure 41 The Barge "Navigation" Inspection Topic

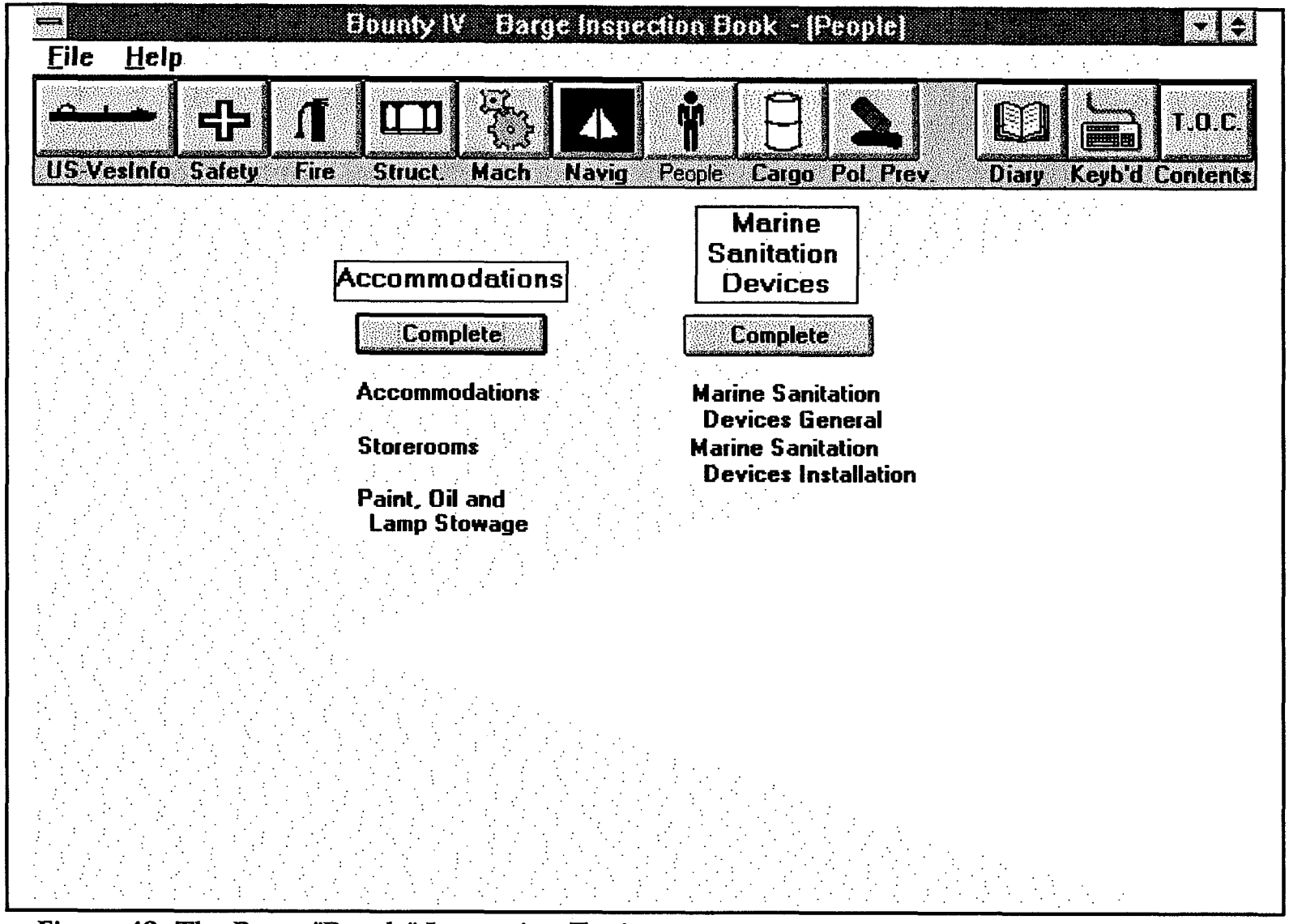


Figure 42 The Barge "People" Inspection Topic

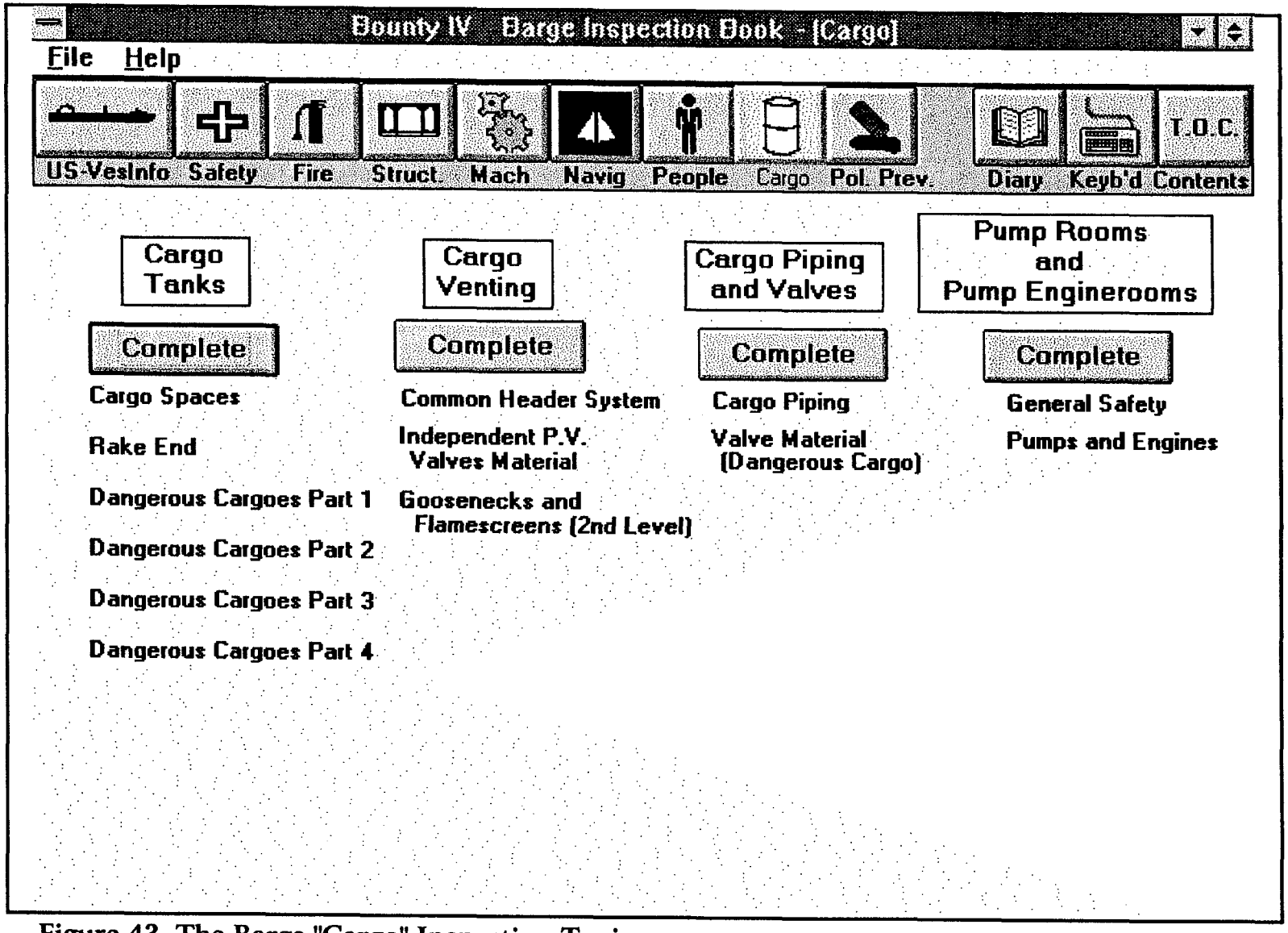


Figure 43 The Barge "Cargo" Inspection Topic

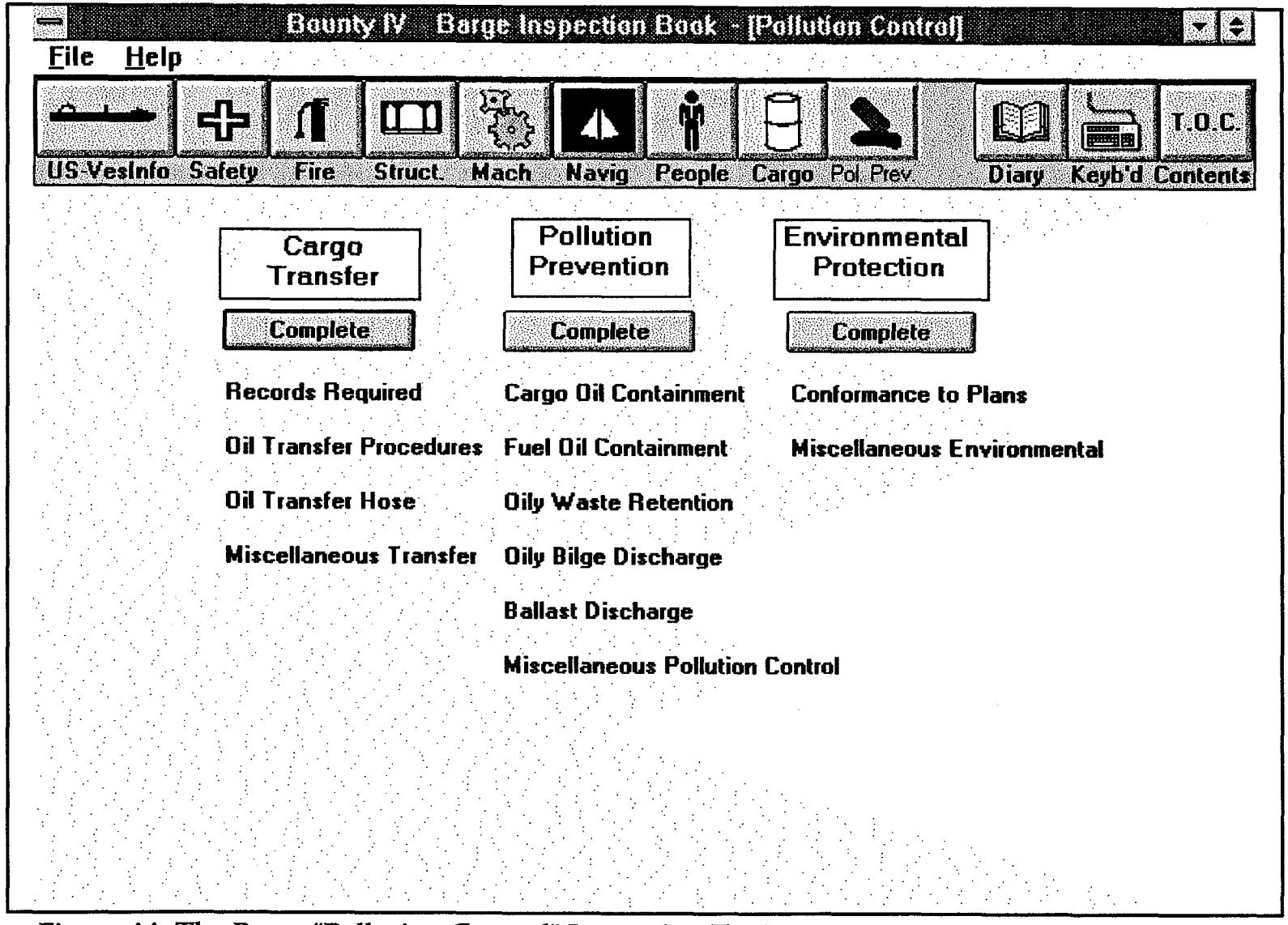


Figure 44 The Barge "Pollution Control" Inspection Topic

APPENDIX C THE WINDOWS for PEN COMPUTING GESTURES

Figures 45 and 46 are a copy of the Windows for Pen Computing reference card.

PEN COMPUTING QUICK REFERENCE

Basic Gestures

Action	Gesture	Example	Result	Tip
Edit Text			The selected text is moved to the Edit Text dialog box.	Make the second part of the gesture much longer than the first. If it's too short, it may be mistaken for a "v."
Backspace		Sample tex	Sample tex	Overlap the lines. Draw at a 45° angle up and to the left and then down and to the right.
Insert Space		Sample text	Sam ple text	Draw the horizontal part longer. If it's too short, it may be mistaken for an "L."
Insert New Line		Sample text	Sample text	Draw a sharp corner.
Cut			The selected text is deleted, then copied onto the Clipboard for future use.	Keep the loop small.
Undo			The results of the previous action are cancelled or reversed.	Draw the tail of the gesture long. If it's too short, it may be mistaken for an "o."

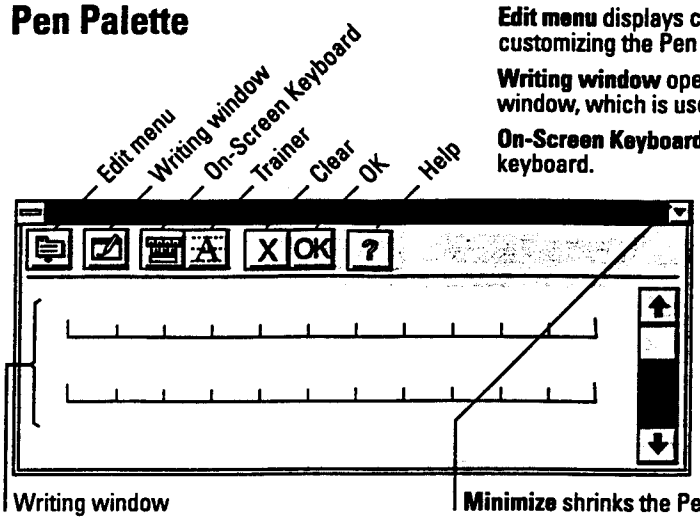
Additional Gestures

Action	Gesture	Example	Result	Tip
Copy			The selected word is copied onto the Clipboard for future use.	Draw the tail of the gesture long. If it's too short, it may be mistaken for an "o."
Paste			The contents of the Clipboard are pasted at the point of the gesture.	Keep the lines straight. Draw a sharp angle.
Delete			Sample	Overlap the lines. Draw at a 45° angle up and to the right and then down and to the left.
Delete Word		Sample text	Sample	Overlap the lines. Create the gesture as one stroke, not two. Draw the line in the middle of the word.
Extend Selection			Sample text	Overlap the lines. Do not lift the pen between the downward stroke and the upward stroke.
Insert Tab		Sample text	Sample text	Draw the horizontal stroke longer. If it's too short, it may be mistaken for an "r."

Figure 45 Side 1 of the Windows for Pen Computing Reference Card

PEN COMPUTING QUICK REFERENCE

Pen Palette



Edit menu displays commands for editing text and customizing the Pen Palette.

Writing window opens and closes the writing window, which is used for writing and editing text.

On-Screen Keyboard opens the on-screen keyboard.

Trainer displays a tool for improving handwriting recognition.

Clear erases all text in the writing window.

OK sends text from the writing window to the active application.

Help displays online Help commands.

Minimize shrinks the Pen Palette to an icon.

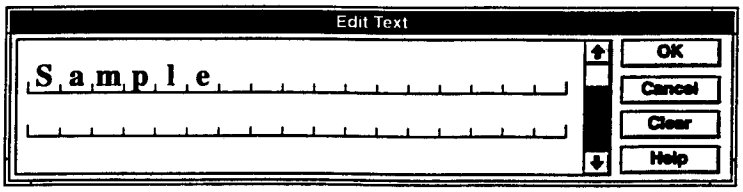
Pen Techniques

Task	Action	Example of use
Tap	Press the pen tip down and then lift it up.	To choose tools, buttons, menus, and commands, tap them.
Drag	Press and hold the pen tip down while you move it.	To move a window, drag the title bar. To size a window, drag the window border.
Select	Press and hold the pen tip at the beginning of the text you want to select. Drag the arrow pointer to highlight everything you want to select.	To delete a word, select the word, and then draw the Delete gesture.

Correcting Text

Sample text

1. Draw the **Edit Text** gesture over the text you want to correct. The Edit Text box will appear.



2. In the **Edit Text dialog box**, do any of the following:
   - Write over incorrect characters
   - Tap the Clear button to erase all text
   - Use gestures to edit the text (see other side of this card)

3. Tap the **OK** button.

Figure 46 Side 2 of the Windows for Pen Computing Reference Card

APPENDIX B Workshop Report from May 17, 1994 Inspector Workshop

This appendix contains a report of information obtained during the mid-project inspector workshop held at MSO New Orleans on May 17, 1994.

USE OF THE TWO MPIU SYSTEMS

Hardware Use

LTJG Rob Nelson used the Dauphin system and LTJG Jim Stewart used the Compaq system. They plan to pass the systems on to other inspectors and to train them in the use of the systems during the remainder of the project.

LTJG Nelson did not bring the laptop computer with him on any inspections. Neither of the inspectors apparently used either the printer or the CD-ROM units in the field. It was clear from their lack of understanding of the MPIU report printing function that they had not used the printers very extensively.

Software Use

So far, the tankship program has been used more than the barge program. The inspectors had not used ZYFind extensively to access 33CFR and 46CFR. They only used the Lloyd's Register RuleFinder program briefly for familiarization. However, they did mention an increasing need for some of the international regulatory material which is contained in the RuleFinder package.

THE NEED FOR A MARINE SAFETY DATABASE INTERFACE

The inspectors felt that the lack of an interface between the MPIU and marine safety database was the most glaring omission in the design and execution of the MPIU pilot project. To them, such an interface would be the primary advantage of an inspection computer system. this interface would, hopefully, reduce the interaction time with marine safety database without eliminating any of the necessary results of those interactions.

The average inspector's interactions with marine safety database account for about 1/3 of the entire time devoted to an inspection. Of this marine safety database time, only a small part of it is used for coding and entering deficiencies. In fact, for a vessel with no deficiencies at all, the time is not substantially shortened. The interactions with marine safety database are in two stages - first, before the inspection, when the inspector prints out vessel information (the MIPIP), the vessel's marine inspection history (Port Safety Vessel History), and other information. The second stage happens after the inspection, when records of the inspection (including, but not limited to deficiency information) and the inspection narrative supplement (which is more or less the same as the inspector's inspection diary) are entered.

The COI is printed by marine safety database, and various steps of administrative review take place on the system before the results are finally validated.

Administrative review requirements are not likely to decrease. With parts of the marine safety database records now available to the public, OCMI's are increasingly concerned about the professional appearance of their office's products, and are less likely to allow subjective judgements or unsupported statements to become part of the official record.

The inspectors are concerned that an interface between the inspection computer system and the marine safety database might turn into an addition to the marine safety database which might require inspectors to spend more, not less, time on marine safety database.

Printing Inspection Forms

The inspectors presently carry a number of forms which might be need to be issued to a vessel during an inspection. Most of these are interim copies of forms which are eventually generated and printed by marine safety database in final form. Some inspectors carry a large folder of forms which they might need during inspections, and they fill them out by hand when they need them. The inspectors who used the systems felt that handling and printing these forms would be a perfect task for the MPIU system. The forms include Temporary COIs, Permits to Proceed, etc.

THE INSPECTORS' OVERALL ASSESSMENT OF THE MPIU SYSTEM

The two inspectors concurred on two primary points:

1. They clearly felt that it took longer to conduct an inspection with the pen-computer than using the traditional pencil and notebook method.

2. They felt that there was no need to carry a computer around the ship during an inspection. The computer would be just as helpful and would not be a hindrance if it were left in a shipboard office. The inspector or inspectors would make their rounds of the ship, then return to the office, discuss their findings, and enter the necessary information into the computer.

Time Required to Conduct the Inspection

Both inspectors were apparently under the misconception that they were required to make an entry (SAT / UNSAT/ NA) in every field of the MPIU programs, rather than just recording deficiencies. The check marks on individual inspection items are optional, and were included in the design to accommodate those offices which still use require inspectors to initial every bulleted item in the book and which use the completed book as the official record of the inspection. When New Orleans was selected as the location of the field tests, the software was modified to accommodate their system of recording inspections, and this was

explained in the Users' Manual. The inspectors had apparently not read the manual in detail. The program can be used to record comments only. It is not necessary to make "SAT" or "NA" check marks for items which are not deficient, nor is it necessary to make the "UNSAT" check marks for deficient items as long as comments are linked to all deficiencies.

The inspectors' observations that inspections took much longer using the computer apparently stemmed from their attempts to enter a check mark for every item in the program. They apparently had not used nor did they understand the report-printing function of the software. They also did not understand the meaning of the various categories of comments or the concept of clearing open comments after a deficiency had been completed. The use of the print function would have made clear the distinction between open, cleared, and general comments, and would have made the inspectors aware that an "open" comment linked to an inspection check-off item flags an item as "deficient" regardless of the state of the check mark, and even if the check mark is blank.

Training Issues

The problems noted above indicate that for future versions of inspection software, more extensive training will be required. Inspectors cannot be expected to become fully proficient with the software by simply reading the manual on their own after a short orientation lecture. Training should include a follow-up session after the inspectors have used the system for a short time. This will help to ensure that inspectors are using all of the capabilities of the programs.

Distractions from Inspection Due to the Computer

Both inspectors concurred that carrying and using a computer during their rounds of a vessel distracts them from their primary task, which is to evaluate the vessel's condition. Conducting a thorough inspection in a reasonable amount of time requires a high degree of concentration and alertness, along with quite a lot of physical exertion from climbing and crawling in tight spaces. They felt that conducting a good inspection and looking out for their own physical safety required a different mental state than did entering information into a computer, and that the computer was a potentially dangerous distraction.

Overall Ease of Use

LTJG Stewart is an experienced Windows and DOS user. He had difficulty with the handwriting function of Windows for Pen Computing, even after training the computer to recognize his particular style.

LTJG Nelson is an experienced on Apple MacIntosh user. He had difficulty adapting to the Windows interface, which he felt wasn't nearly as intuitive as the Mac interface, especially when files had to be manipulated.

DETAILED COMMENTS ON THE MPIU SOFTWARE

Navigating the Software

The inspectors found the use of the software to be particularly time-consuming in areas of the vessel such as the bridge, which contains inspection items which fall under a number of topics. They found it much more difficult to locate all of the required items in the software than in a paper inspection book or checklist. Some of this difficulty may stem from their misconception that they were required to check off every item, rather than just recording the deficiencies. However, it is clear that the multi-level hierarchical organization of the software, (which is due mainly to the limited amount of information which can be presented clearly on one screen), does make it difficult to work in several different inspection topics concurrently. This is an area in which the software interface needs more work.

Use of the Table of Contents function of the MPIU software could significantly alleviate this problem for a fairly experienced user, by speeding up the process of jumping between topics. The TOC in the present programs uses the hierarchical organization of the original books. This was done for the benefit of inspectors familiar with the book's organization. In future versions, a TOC based on the actual organization used in the program might be even more useful. The inspectors at the May 17 Workshop did not comment on their use of the TOC.

Another possible solution would be to organize inspection items by parts of the vessel rather than by topics. This approach was suggested to, and was rejected by the majority the inspectors who were interviewed during the development of the requirements for the inspection computer system. Perhaps this strategy deserves another look.

Problems Resulting from Basing the Software on the 840 Series Inspection Books

The inspectors found four principal problems with the software, all based on recent changes in inspection documentation procedures which have been implemented in the New Orleans office:

1. The inspection books, particularly the tankship book, are out of date. A number of new regulations and inspection procedures have come into effect since the book was published in 1978. Inspectors, therefore, must inspect a number of systems (such as vapor recovery systems) which are not covered in the book. The MPIU software does not presently allow for easy documentation of additional inspection items.

   The inspectors suggested that the software could be modified to allow each office or individual inspectors to add new fields to the software. This is certainly possible to do. It would use the same capabilities of the software which allow unlimited numbers of comment or ink forms to be generated for any inspection item. However, the standardized structure of the database would be compromised, and inspection files

would no longer be easily interchangeable between units which used different inspection configurations.

2. The way inspections are now conducted in New Orleans no longer follows the strict divisions of the inspection books. During a tankship inspection, for example, not only the hull inspection, but at latest part of the machinery inspection (another book) are done simultaneously, and the results are combined into a single report. It appears that the overall organization of inspection software will have to reflect this abandonment of the strict divisions of inspection type reflected in the present inspection books.

3. The differences between the inspections of U.S. and foreign flag tank vessels have changed considerably since the tankship book was developed. Many of the items which the book indicates are inspected only on U.S. vessels are now, in fact, inspected on both U.S. and foreign vessels. And several categories (such as officer licensing) which, according to the book, are only included in the tankship inspection for foreign vessels are now inspected for U.S. vessels as part of the tankship inspection.

4. Foreign-flag freight vessels (container ships, general freight vessels, and bulk carriers) are now inspected using a checklist very similar to that provided by the tankship book for foreign tank vessels, except that certain hazardous material categories are omitted. these vessels now represent another special case of the tank vessel inspection book.

It is clear that there are, and will continue to be, fairly major differences in the ways different inspection offices conduct and document inspections, especially those of deep-draft vessels. In order for inspection software to be used throughout the system, these differences will have to be addressed without losing the intercompatibility of inspection data files between various offices.

In some inspection offices, the inspectors are expected to initial every bulleted item in an inspection booklet to show that they conducted a complete inspection. In New Orleans, however, this practice was abandoned some time ago, partly because the inspections books are out of date. The current practice there is to use the diary (which becomes the marine safety database narrative supplement) as the record of the inspection and to record only the deficiencies. In general, all deficiencies, not only those still outstanding at the end of the inspection, are recorded. Inspectors use the inspection book, in combination with personally developed checklists incorporating newer regulations not found in the books, as memory aids only. The diary becomes the official inspection record. Deficiencies still outstanding at the end of the inspection are entered into marine safety database.

File Handling and Naming

The names assigned to inspection directories and files give no indication of the name of the vessel they apply to. In fact, the inspection data files for each ship have exactly the same names (INSP.DAT, INSP.BAK, SUMMARY.DAT, and DIARY.TXT). These files are differentiated from others of the same name by the directory in which they reside. The directories are named INSP0001, INSP0002, etc., which gives no indication of the ship's name. Understandably, the inspectors found this confusing when transferring files. They suggested that both the names of the data directories and the names of the files in those directories incorporate the vessel's name. [This could be done without too much trouble, using the file extension to identify the type of file, and leaving the 8 characters of the file name to identify the ship. When an marine safety database interface is designed, the issue will have to be addressed. Windows 4.0, which is due soon, will reportedly allow 16-character file and directory names, which will make the use of unambiguous and descriptive names much easier.]

Recommended Minor Software Changes

Both inspectors stated that at the upper levels of the program hierarchy (first-level forms and second-level forms), they would like to be able to set all of the check marks in the tree structure below that level to "SAT" or "NA" without requiring the inspector to go to each third-level form and check each item. [This can be implemented easily, however, it may be against the policy of those offices which still require inspectors to initial each item in the book. This request is partly the result of the inspectors' misconception that they had to make a check mark for every item. [Leaving all check-off items in their default (blank) state does not have any detrimental effect except that the "Incomplete" indicators do not help steer the inspector to area which have not yet been covered. It is obvious that, if they want to set the buttons to "SAT" by default, they must feel they do not need indicators to tell them what areas they haven't yet covered.]

The inspectors suggested that when large parts of the inspection program are inactive because of the type of vessel being inspected (for example, parts of the tank vessel inspection which are inactive for foreign vessels), those areas be locked out at a high level, so inspectors do not have to go all the way to the third level to find that there are no active items there. Inactive items are presently grayed-out and the check mark buttons are inactive. [This change presents no problems. We considered doing this during program development, but decided that inspectors might want to make comments on inactive inspection items, so we retained access to the grayed-out items, making the check mark buttons inactive.]

Use of Supporting Software

Neither inspector had used ZYFind extensively. They appeared to have not used it enough to really evaluate its effectiveness. Possibly, during the particular inspections which were done with the MPIU system, no need arose to consult the reference material accessed by

ZYFind. ZYFind is not available on the Dauphin, and since LTJG Nelson did not bring the laptop computer with him on inspections, he did not have access to the reference material while on board vessels he inspected.

DETAILED COMMENTS ON THE HARDWARE

Dauphin vs. Compaq

Since the two inspectors had each used only one of the systems, they could not compare the relative merits of the large and small pen computers. There seem to be more problems with unexplained system crashes and reboots with the Dauphin than with the Compaq.

Digital Cameras

Both inspectors used and were enthusiastic about the potential of digital photography, despite the somewhat cumbersome nature of the FotoMan download process. [The next generation of digital cameras will hopefully streamline the process of downloading pictures into the computer. The new Apple color digital camera, which works with Windows systems as well as with Apple systems, downloads directly to the computer without requiring a base station.]

One inspector found that his computer had to be rebooted in order to recognize the presence of the camera once it was connected. In addition to this inconvenience, and that of the rest of the download process, they both lost pictures because of discharged batteries power in the cameras (there is no battery condition indicator on the camera). This problem was aggravated by the procedure they generally used for downloading - they waited until the inspection was over and they downloaded the pictures after they had left the vessel. When they found that the pictures had been lost due to low batteries it was too late to take them over. With a direct-downloading camera, it will be easier for inspectors to download immediately, to view and check the quality of the pictures, and then to retake them, if necessary. Keeping the camera battery power up for an entire inspection and for a large number of pictures may be a problem which needs to be addressed, even with the more advanced cameras which are now becoming available.

Hardware Problems

Data loss was experienced on several occasions with the Dauphin. The inspectors suggested a timed automatic save function to limit the amount of information that would be lost in the case of an inadvertent system shutdown. This could be implemented easily. [The software presently allows data to be saved on request at any time at the inspector's convenience.]

The screens of both the Dauphin and the Compaq are difficult to see in the unshielded bright sunlight conditions on the deck of a vessel. Both inspectors tried all combinations of screen brightness and contrast, but they were not able to make the display clearly visible in bright light.

SUMMARY

The inspectors seemed to feel that the ideal inspection computer system would be based on a laptop computer, possibly with a color screen to support color digital photography, and possibly pen-enabled, to take advantage of the ability to make sketches and annotate photographs with the pen. The inspector would leave this computer in a shipboard office and return to fill out his or her inspection report.

The computer would upload all pre-inspection information from marine safety database with minimal help from the inspector. Any forms which might needed during the inspection could be filled out and printed on board from the computer. After the inspection, the inspection record would be downloaded to marine safety database and the various marine safety database products relating to the inspection would be updated with minimal inspector interaction.

Final Meeting

LTJG Nelson will be out of the office from June 10 through June 27. LTJG Stewart will be out for three weeks beginning on June 13. So far, no other inspectors have used the systems, and no inspector has used both for comparison purposes. Rob and Jim plan to pass both systems to other inspectors for the remainder of the project.